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MECHANICAL EQUIPMENT OF A MODERN HOSTELRY

Plenum System of Ventilation Furnishing Washed Air To Lower Floors and Basement; Vacuum System of Heating; Electric and Hydraulic Elevator Equipment

TOOT T-O-O-T, WITH A SUDDEN start I awoke from a half sleep as the "brakie" yelled Syracuse, S-a-r-y-cuse, and sure enough we were pulling into the station. Hi, ho! it was Christmas eve and I was many miles from home. It made a fellow think of the days when he was a kid and brought to mind a phrase from that old nursery rhyme, " 'Twas the night before Christmas and the house was all dark"—but what's the use, the only thing left for me to do was to "hike" over to the Onondaga Hotel, be as cheerful as possible and go down Christmas morning to see my friend the chief engineer and learn some more details of his plant.

Christmas morning I was up bright and early and started for the underworld, not meaning the habitat of professional crooks and Paris apaches, but the region where we can truthfully repeat the old adage, there are "wheels within wheels."

I had nearly forgotten the way to the engine room, it is in the sub-basement you know, and as I was hurriedly passing through the "mystic maze" of kitchens and pantries in the basement, I abruptly turned a corner and bumped "pell mell" into a waiter bearing aloft a sizzling turkey. Say, the monologue that followed, I say monologue because I could not get a word in edgewise, would have turned a vaudeville artist the shade of the Emerald Isle with envy.

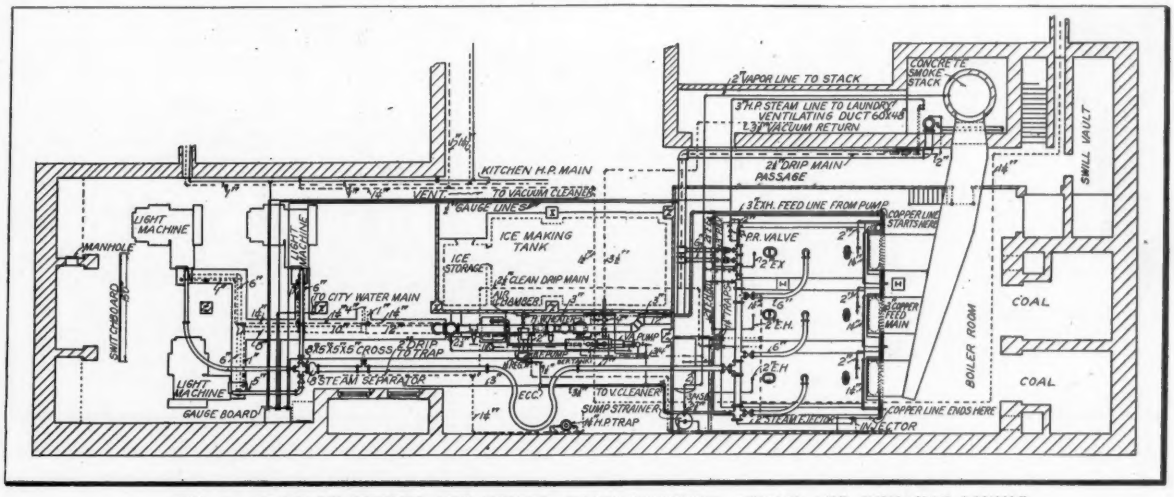


FIG. 1. PLAN OF ENGINE AND BOILER ROOM SHOWING STEAM AND EXHAUST PIPING

"Whata the mat, canna you no see where you go? Maka me spilla the turk, perhaps loosa ma job." A few other stronger words were interpolated and 'twas small wonder, that much to the chagrin of the steward, the entire supply of Christmas ice cream was found boiling over the tops of the cans. The downfall of

You will remember that in the Dec. 1 issue, we told you something about this plant, especially the refrigerating and ice-making machinery, but on this bitterly cold night the heating and ventilating equipment seemed a more logical subject to follow up on the morrow.

Turkey did not create any visible stir among the help as it had been chronicled many times in the daily press, but as I had no desire to sever my diplomatic relations with Italy I showed the color of a brand new quarter and advised the liberal application of soap and water to restore the bird to the condition it showed before it rubbed its back over 3 yards of concrete.

Well I finally found the stairway leading down to the engine room, without further incident, and greeted my friend the chief with a "good morning and a Merry Christmas." "Good morning and a Merry Christmas to you sir; glad to welcome the 'stranger within our gates' once more. Sit down." We pulled a couple chairs up to his desk and proceeded to smoke the pipe of peace consisting of a couple of Practical Engineer's best perfectos which are guaranteed to be high in B.t.u.'s and, if you don't pull too hard, the city smoke inspector won't make you use an automatic stoker.

"Well chief tell me your troubles first," I could see that he looked tired and worn and as I was always pretty strong on the sympathy stuff, thought I might cheer him up a bit. "It's this way" he replied, "the house is crowded with guests, we had several banquets in the different dining rooms last night and a dance in the big ball room, and to cap the climax the weather man kicked out the bottom of the thermometer, compelling us to "shoot" live steam into the heating system, all this extra load, mind you, and one of our boilers out of commission. Well I haven't been home since yesterday morning and I was to play Santa Claus for the children last night and I can see them in my mind with their little noses pressed up against the window pane anxiously looking for their pop."

Just then my glass eyes became misty and I looked around for a leaky stuffing box—say that is a poor excuse isn't it? Well I was thinking pretty strongly about that time of my kiddies at home and something seemed to come up in my throat about the size of a barrel of lubricating oil.

"Don't let me keep you a minute chief, go home and be happy; just give me permission to "butt" around for myself, and that's all I'll ask."

"Sure, my boy, go as far as you like. Goodbye and don't fail to drop in and see me when you are in the city."

I then proceeded to do the Sherlock Holmes act and set out looking for clues that would lead me to the ends of the multitude of pipes that radiated from the engine room like the appendages of a thousand legged worm. The following pages relate the result of the sleuthing.

Steam Piping

FIGURE 1 shows the general layout of the boiler and engine room, with the location of boilers, generating units, piping and auxiliaries. Steam outlets from the 3 boilers are 6 in. in diameter and each one is connected to the 10-in. header by an ell and long radius horizontal bend with a 6-in. gate valve near the header joined to the tee connection. The main steam line for supplying the engines and ammonia compressors is 7 in. in diameter, runs at right angles to the header and is provided with a double expansion bend between the boilers and engines, and a 7-in. gate valve near the header.

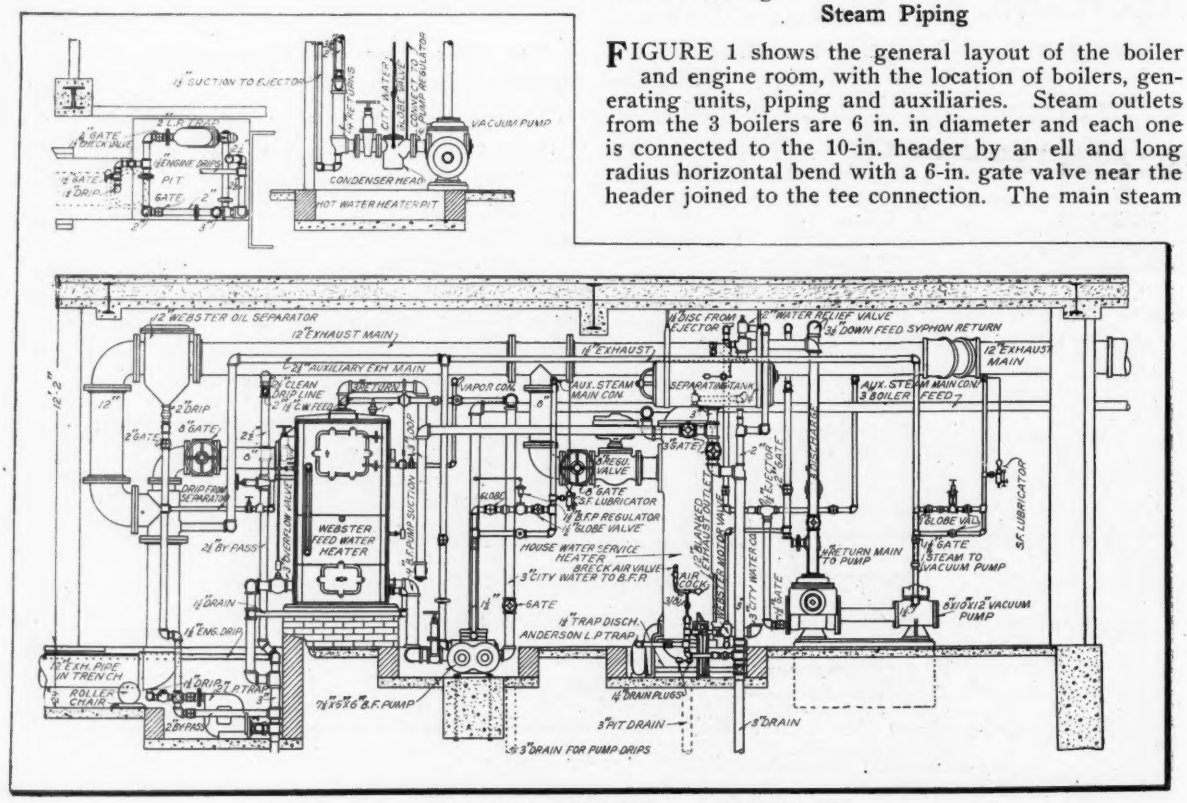


FIG. 2. DETAILS OF APPARATUS IN THE PUMP PIT

The main pipe terminates in an 8-in. steam separator which has a 1¼-in. drip to the trap. Connected on the engine side of the separator is an 8 by 5 by 5 by 5-in. 4-way connection with 5-in. gate valves at the 3 5-in. openings; from these openings 5-in. pipes lead to the 3 150-hp. engines. The ammonia compressors are supplied with steam by a 2½ and a 1¼-in. pipe respectively, connected to the steam main but not shown in the illustration.

Exhaust pipes from the engines are 6 in. in diameter; a single 4-in. exhaust pipe serving the 2 ammonia compressors. These pipes are connected to the 12-in.

exhaust main, by suitable couplings, the latter being carried up through the ventilating shaft to the roof level parallel to the stack, as shown in Fig. 3. In the engine room, the exhaust main is concealed in a trench under the floor and is supported by rollers resting on chairs.

Two 6-in. pipes connect the header with the exhaust main for supplying live steam to the heating system in severe weather. Steam is controlled in each pipe by a reducing valve and 2 gate valves, located as shown in Fig. 2. Two 2-in. pipes also branch from the header for supplying live steam to the kitchen; each of these pipes having an equipment of valves similar to the 6-in. pipes.

Pump Pit

FIGURE 2 shows the details of the pump pit. At the lower lefthand corner is shown the 12-in. exhaust pipe in the trench under the engine room floor where it leads to an ell and extends upward to a tee from which an 8-in. branch connects to a Webster open heater; the steam is controlled by an 8-in. gate valve and vapor from the heater is conducted by a 2-in. pipe to the stack.

By means of an ell from the horizontal tee branch the 12-in. pipe extends upward for a short distance to a second ell and connection to a 12-in. Webster oil separator; the separator is drained by a valve and 2-in. pipe. The drain pipe connects to a 4-way coupling in the trap pit to which is joined a 1½-in. drip from the ell in the 12-in. exhaust main, with a check valve between the ell and the 4-way coupling.

From the righthand side of the 4-way coupling there is a connection to a 2-in. low-pressure Anderson trap controlled by a 2-in. gate valve draining to the sewer. From the lower end of the 4-way coupling there is a 2-in. bypass leading to the sewer which is controlled by a 2-in. gate valve. A 3-in. overflow from the feed-water heater and a 2½-in. clean drip bypass from the 12-in. exhaust main also connect with the drain to the sewer. The exhaust from the vacuum pump and from the boiler feed pump is taken care of by a 2½-in. pipe which taps the ell below the Webster oil separator.

Returns from the heating system are pumped by an 8 by 10 by 12-in. vacuum pump to a Webster air separating tank through a 3-in. pipe, thence through a 3-in. pipe and a 3-in. loop to the Webster feed-water heater; there is also a 1½-in. city water connection to the heater. An elevation of the water end of the vacuum pump is shown in detail in the small figure in the upper part of Fig. 2. The returns are controlled by a gate valve and, before entering the cylinder of the pump, pass into a condenser head cooled by city water. From the return head a 1½-in. suction leads to an ejector.

For house service water there is a Wainwright water heater supplied with steam through an 8-in. connection to the exhaust main, an 8-in. gate valve and an 8-in. regulating valve. Drains from the water heater are relieved by a 1¼-in. Anderson low-pressure trap.

The 7½ by 5 by 6-in. boiler feed pump receives water from the heater through a 4-in. suction; there is also a 3-in. city water supply to the pump; the feed water is pumped through a 3-in. pipe to the boilers. The pump is controlled by a boiler feed pressure regulator connected to the pump steam line and to the boiler feed water line. Details of the boiler feed piping in the boiler room proper are shown in Fig. 1. The boiler feed pump is supplemented by an injector, which is used in emergencies.

Figure 3 shows the details of the exhaust piping, in the air shaft, which extends above the roof level; the total length of the riser to the base of the exhaust head is 177 ft. At the level of the pent house floor

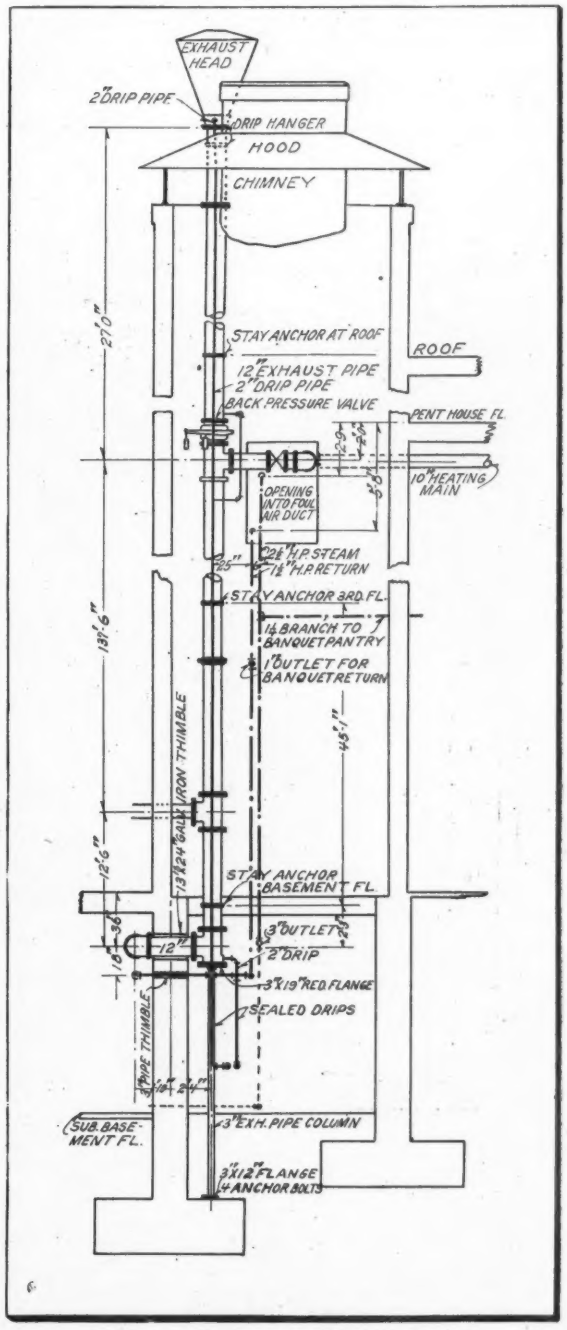


FIG. 3. DETAILS OF EXHAUST RISER

there is a back-pressure valve and is a 10-in. heating main connection; there is also a 6-in. heating main connection in the basement. The exhaust head returns and the condensation from the bottom of the riser are carried to the feed-water heater by a 2-in. drip pipe. A drip pipe is tapped into the exhaust main above the

back-pressure valve and is connected to the exhaust head drip pipe. The exhaust riser is supported by an extra heavy pipe column at the base and by stay anchors at the basement, third, seventh and eleventh floors and at the roof, and the drip pipe is supported by drip pipe hangers attached to the exhaust riser.

Ventilation

VENTILATION of the building is accomplished by exhausting the foul air into air shafts and supplying fresh air to the basement first floor and mezzanine floor by means of the plenum system, location of the ventilating and fresh air ducts being shown on Fig. shaft extending to the top of the building. The air passes over heating coils and then through the washer, which consists of a framework of troughs filled with coke over which a curtain of water passes, into the fan room in which is located a motor-driven Buffalo Forge Co.'s fan 14 ft. in diameter and 4 ft. wide, with a capacity of 10,000 cu. ft. of air a minute. The fan forces the air through a canvas connection to the tapered mouth of the main duct 48 by 42 in. which is changed to 128 by 18 in. and gradually decreases in size toward the end. The location of the ducts and risers with their respective dimensions are plainly shown in the figure.

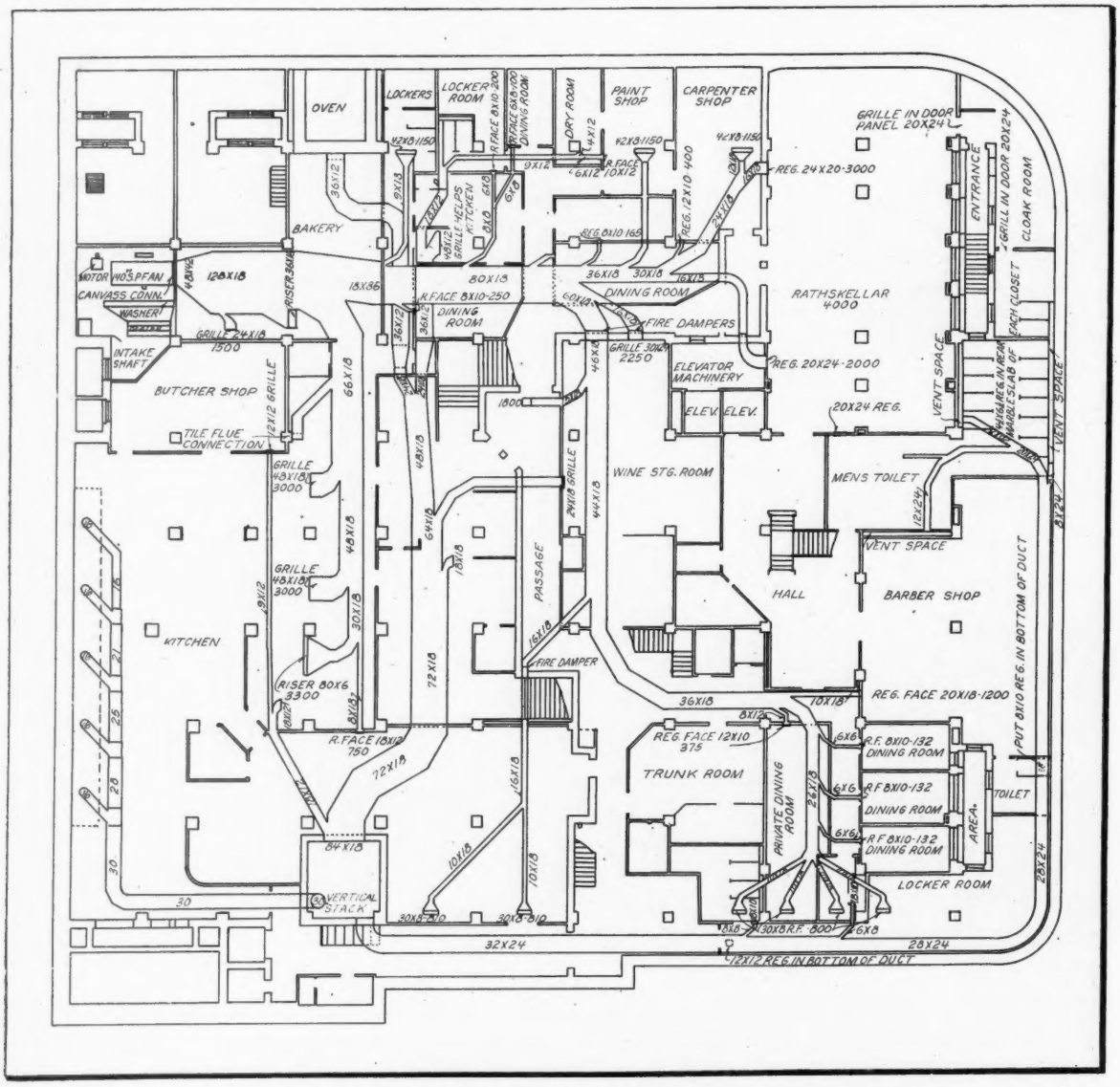


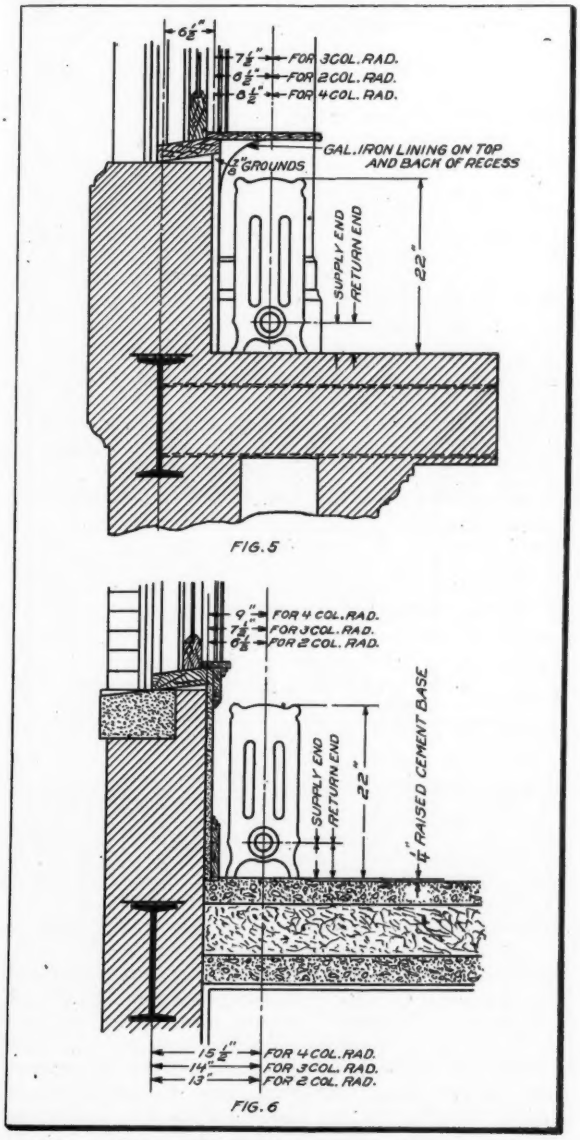
FIG. 4. PLAN OF BASEMENT SHOWING DETAILS OF VENTILATING SYSTEM

4, the basement plan. It will be noticed that the branches from the fresh air ducts that supply the basement floor are indicated by arrows, while the risers for the first and mezzanine floors are indicated by horizontal cross sections at the ends of the branch ducts. By referring to the upper lefthand corner of Fig. 4 it will be seen that fresh air is received from an intake

This system not only furnishes an abundant supply of fresh air but, of equal importance, imparts humidity or moisture to the air by the washing process. Under normal conditions the outside air has a relative humidity varying from 50 to 75 per cent of full saturation which is the maximum amount of moisture one cubic foot of air can hold. When the relative humidity

is much above or below the normal limits, ill effects are experienced, the higher the temperature the more noticeable the deficiency of the moisture.

In artificially heated buildings, without special provision, the percentage of moisture never reaches normal, therefore it is important to supply the deficiency by artificial means which is accomplished by the system employed. The heater is sufficiently large to maintain the temperature of the air after leaving the



FIGS. 5 AND 6. ROUGHING IN PLAN FOR RADIATORS

washer at from 60 to 70 degrees in the severest weather. In hot weather the cooling effect of the washer reduces the temperature of the incoming air in the neighborhood of 10 deg., thus lowering the temperature within the building.

Heated and foul air from the kitchen, bakery and other departments of the basement floor is removed by a separate system of ducts leading into a vertical stack which runs to the top of the building. Throughout the building ventilating ducts and air shafts are provided for ventilating the toilet rooms.

Heating System

FOR the basement heating there are 15 standard radiators with a combined radiating surface of 891 sq. ft., 15 wall radiators with a combined radiating surface of 450 sq. ft. and a wall coil 10 pipes high 7 ft. by 15 ft. containing 220 ft. of 1¼-in. pipe with 96 sq. ft. of surface, making a total radiating surface of 1437 sq. ft. The approximate overall dimensions of the basement are 152 by 168 ft. and 12 ft. high, having

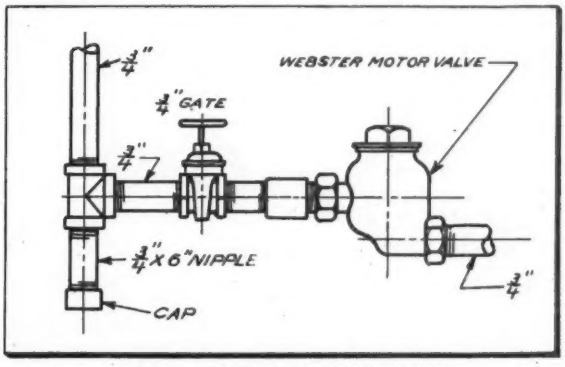


FIG. 7. BASE OF SUPPLY RISER

a contents of about 306,432 cu. ft. which provides 1 sq. ft. of radiating surface for each 220 cu. ft. of contents.

The first and mezzanine floors have to be considered practically as one, as there is a rotunda in the center extending to the floor line of the second story where a sky light is located. The general dimensions of the building at the first floor level are 136 by 152 ft. and 18 ft. 6 in. to the second floor level, with a contents including both the first and the mezzanine floors of 382,432 cu. ft. There is a total of 39 radiators on the 2 floors with a combined radiating surface of 2905 ft. which provides 1 sq. ft. of radiating surface to 131 cu. ft. of contents. This is a ratio of 1 to 131 as compared to 1 to 220 in the basement, which is accounted for by the fact that the first and mezzanine floors receive some heat from the plenum system and furthermore the building above the first floor line is exposed to the weather on 4 sides. The general arrangement of the radiators used on these floors is shown in Figs. 5 and 6. In the guest's rooms the radiators are set on cement bases.

As an example of heating a large room, let us consider the ball room on the second floor which is 96 ft. long, 40 ft. wide and 14 ft. 6 in. high with an approximate contents of 55,680 cu. ft. Heat is supplied by 8 radiators, 4 at each end of the room. The radiator schedule is as follows:—No. 1, height 22 in., 4 columns, 20 sections, surface 86⅔ ft., recessed; No. 2, height 22 in., 4 columns, 21 sections, surface 91 ft.; No. 3, same as No. 2; No. 4, same as No. 1; No. 5, height 38 in., 3 columns, 12 sections, 60 ft. surface; Nos. 6, 7 and 8 are the same as No. 5. The total radiating surface of the 8 radiators is 595 sq. ft., providing 1 sq. ft. of radiation for 93 cu. ft. of contents.

A typical guest's room 16 ft. square and 11 ft. high is located on the corner of the building and has 2 outside walls and 2 windows. The contents is 2186 cu. ft. which is heated by 2 radiators with a combined heating surface of 60 ft. providing 1 sq. ft. of radiating surface for 47 cu. ft. of contents.

As an example of the heating of an inside room we will select one 10 by 16 ft. and 11 ft. high with one

(Continued on page 227.)

SMALL PLANT RECORDS

Why Records Should Be Kept, the Incentive to do Better Work, Method of Increasing Salary

By A. D. Palmer

I HAVE noted with considerable interest the number of expense charts and diagrams, etc., which have been published in Practical Engineer from time to time, during the last few years. With few exceptions, these charts have all been adapted to large plants; but with the present competition between the central-station solicitor and the engineer operating the isolated plant, it is, if anything, very necessary that the small-plant engineer should have and keep records of his plant's management and operation.

The idea (which some engineers entertain), that the central-station solicitor should be ousted when he visits our plants, is all wrong. Courtesy even to our worst enemy costs nothing, and in nine cases out of ten is a profitable investment.

Personally I allow no man to bulldoze me or meddle with my work, but if a man comes to me with a civil question, he gets a civil answer, and it's a policy that I've found mighty useful. And this holds good in the plant where there is one man, doing his own firing and running, with a dozen other jobs thrown in, as well as the plant where there are a half dozen engineers who never need take off their boiled shirts as far as their work is concerned. In the plant where a log is kept of the plant incomings and outgoings, there (generally speaking) need be little fear of the central station.

System in the engine room is just as necessary as system in the office, and I have found that in the plants where records are kept, the greatest economy is practiced. I can remember when I could not understand this, but now I figure it has been largely due to our desire to do better than the other fellow did.

Let me cite a little case of which I recently heard. In a certain plant in New England, there were 3 operating engineers, whom we will call "Smith, Black and Jones." Smith was an old timer, a splendid engineer as far as operating went, but lacking in executive ability. Black was as good an engineer as Smith and a master man, but, unfortunately, he allowed his home troubles to interfere with his work. Jones was the highest type of engineer, a thorough business man, and a first-class machinist.

Now, this plant had been operating some 6 months, and during that time the superintendent had acted as chief engineer, but his sudden resignation made it necessary for the company to employ a chief, and with this object in view, they asked each of their 3 engineers what pay they would expect to take the chief's position. Smith asked $32.00 per week; Black asked $35.00 for a 6-day week of 8 hr. per day, and Jones offered to take the job for 50 per cent of the saving he could make over the company's present operating expense, and this to hold on a 4-yr. contract.

The company took Jones' offer, and at the end of 5 months they were very glad to make a new contract, Jones to get $50.00 per week, and a bonus upon his keeping the bills down to his own standard. Not so bad for a stationary engineer, what? Jones took a big chance? Not at all. From the day Jones began work in that plant, he kept a private log sheet covering every item of expense that it was possible for him to ascertain, and this with his business ability, showed him where his company was wasting hundreds of dollars. I have been told by other engineers that the first week Jones was chief he plugged one leak that effected a saving of from $150 to $200 per month.

I realize, of course, that every engineer is not the business genius that Jones is, and I've only cited this case to illustrate what system will do. It will surprise one, how even in the smallest plants, an operating and

PLANT ENGINEER IN CHARGE

ENGINEER'S WEEKLY REPORT

DATE	DAY	COAL, LB. BIT.	COAL, LB. ANTH.	WATER METER READING, 7A.M.	BOILER REMARKS	ENGINE RUN, HR. NO.1	ENGINE RUN, HR. NO.2	AIR COMPRESSOR RUN	VACUUM PUMP RUN	OIL USED, PINTS CYL.	OIL USED, PINTS MACH.	OIL USED, PINTS AIR	OIL USED, PINTS	WASTE USED LB.	INCOMING ELECT. READING	REPAIRS	ELECT. OUTPUT, WATT-HR.	AVERAGE STEAM PRESS.	AVERAGE AIR PRESS.	AVERAGE FEED WATER TEMP.	REMARKS
16	MON.																				
17	TUES.																				
18	WED.																				
19	THUR.																				
20	FRI.																				
21	SAT.																				
22	SUN.																				
TOTAL COST																					

REPAIR SLIP

DATE.
SUPPLIES USED.

WORK FIN'SHED, DATE. SIGNED,

SUPPLIES RECEIVED DURING WEEK	COST

REPORT FORMS FOR SMALL PLANT

expense chart will cut down bills, and settle arguments.

Of course, every engineer can draw out a chart to meet his own requirements, but others' ideas often help us to note details we would otherwise overlook.

The accompanying chart is one I have used off and on for some 10 yr., and I've found that it covers most of the needs of the smaller plants.

A PLEA FOR HEAVIER BELT PULLEYS

By Wilbur R. Smith

A FEW years ago the weight of cast-iron pulleys was determined by practical precaution; after scientific analysis and deduction have been brought into play, however, their proportions are arrived at by considering dimensions and strength of material as compared with the strain to be borne and allowing a factor of safety, which, should the actual working strain to which the pulley is put be as assumed, and the material a homogeneous mass of the properties per inch as estimated, would perhaps, be more than enough and in the statement may appear high.

That this is not the case, however, and that there are many factors entering into the equation which more torque or stress per assumed hp. does not in any way provide for, I believe any one who has had practical experience with belt transmission will agree. And although many of these should technically no doubt be considered as abuses, yet I think that manufacturers of iron pulleys should take them into consideration and provide amply for them for self protection and the reputation of their goods if for no other reason.

In the first place there are variations in strength of material in the pulleys themselves which should be guarded against by excess of weight. Flaws and blow holes, chills and shrinkage strains may be estimated scientifically by one skillful with a pencil, but in practical application prove a law of exceptions.

With a desire to be more than fair to the manufacturer, let us assume that least among the causes of failure in cast-iron pulleys is defective material, and assuming perfect proportion and distribution of material to obtain 100 per cent of given weight, the variation of conditions under which the pulley may reasonably be expected to work demands attention.

Examples are sudden starting with hard pull on slow speed, for instance where a large pulley drives a heavy load of transmission which in turn is belted up to high-speed machinery; improper designing of belt speeds, as for instance where belt speed may be reduced and belt tension increased to get through a close place—bad practice, perhaps, but only what a manufacturer may expect his pulley to encounter and there are few installations but what have an illustration; temperature conditions; for instance a split pulley brought up tight in summer and subjected to freezing temperature the next winter, improperly fitted keys or poorly cut keyways in shafting, things which happen but for which few will admit responsibility; slightly sprung shafting, not bad enough to be considered, perhaps, but causing additional strain on pulleys.

These and many other little things go to make up a "Factor of Danger" which, sometimes equal to the designer's "Factor of Safety," can be expected to confront a pulley almost any place where it is sent.

Aside from his reputation which the manufacturer wishes to keep in nice shape, the matter as viewed from a standpoint of profit should cause him to figure carefully whether he is not losing more by claims than he is saving in material, as those causes of failure which may be classed as abuse are usually hard to prove, and a few factory shutdowns in a neighborhood due to pulley failure will offset a lot of advertising.

I have been watching this for several years and noting the weight of pulleys being cut down little by little until I do not see how it can very well be reduced much farther, as some of them now look too feeble to take care of themselves. Of course foundry practice and chemistry have made a reduction possible, but not an extreme.

During the same time as I have been watching and noticing the weights decrease I have also noticed the failures increase, until only recently I saw 3 split iron pulleys bought before one was found which would stand up and do the work on a drive where all conditions were apparently right except the pulley, and where the conditions could not vary much as it was used to drive an exhaust fan, merely a moving air load which I would think about as uniform as a load could be.

I should think that anyone dependent on sound pulleys for continuous operation of mill or factory would be glad to pay a little more for a few pounds of extra iron, and be sure of getting satisfaction and safety.

OIL IN LOW-PRESSURE TURBINES

Care Necessary When Using Exhaust From Reciprocating Engines

WHEN utilizing engine exhaust in a low-pressure steam turbine, difficulty may be encountered in the last stages because of the comparatively low temperature which thickens the oil. In this connection, the following evidence from users of such turbines is interesting.

If oil is allowed to remain in the steam furnished to the low-pressure turbines, it will undoubtedly deposit on the blades and so close up the blading, and, in turn, cut down the capacity of the machine materially. To prevent this a suitable oil strainer should be installed in the low-pressure steam line between the engine and the steam turbines to abstract all oil, dirt and moisture from the steam before entering the low-pressure turbine.

In the low-pressure stages of high-pressure turbines we have in a few cases seen considerable accumulations of organic matter, in some cases the collections being enough to affect the economy slightly. We have not seen this condition in any low-pressure turbines and we have had no complaint which indicated the presence of this trouble. We cannot, however, positively state that such accumulations will never occur. Experience with such accumulations on turbine blades indicates that they form slowly and are easily removed.

In our experience with low-pressure turbines, we have found a few cases in which the blades have been choked by a mixture of cylinder oil and concentrates from the boilers, the result being a decrease in the size of the passages and corresponding effect on the turbine capacity.

So far as our observation goes, this action does not take place where oil only is present, but in case of faulty boiler operation where foaming takes place, scale-forming material thrown over by this will mix with the oil and cause trouble. Generally speaking, steam velocities will not keep the blades clear of accumulations of this kind.

CYLINDER PACKING RINGS

Renewing Them Easily and Successfully. How to Get a Perfect Fit

By F. W. Bentley, Jr.

CYLINDER packing rings of an engine are of importance with respect to the efficiency of the engine, equal almost to that of the valve motion itself. Manufacture and fitting of these rings at the factory, is generally executed to a great degree of nicety by the use of accurate and special machinery for that purpose, but their application to a slightly worn cylinder with the assistance of perhaps only a hack saw and file is a very different proposition.

After a period of service the average engine cylinder presents a peculiar condition of wear that must be primarily considered in the application of new packing rings. The central portion of the cylinder is invariably smaller, as it suffers the least amount of frictional wear, due to the fact that the piston head at this point experiences the greatest buoyant force and velocity from the steam acting on either stroke of the piston. At either end of the cylinder, the head is not subject to this action of the steam upon it, as the reduced steam pressure in the cylinder near the point of the stroke reversal allows the piston and head a greater pressure on the cylinder walls and more prolonged frictional contact. Fig. 1 will make this condition of cylinder wear clear, and it can be readily verified by the application of calipers or micrometers to the walls of any slightly worn engine cylinder.

Allowance for Spring

THE size to which the outside diameter of a new packing ring should be turned to allow for expansion or spring against the cylinder walls is important,

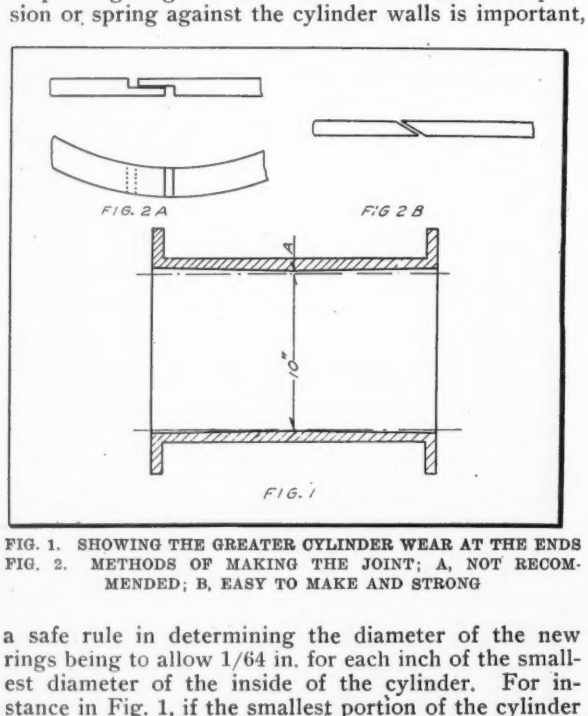


FIG. 1. SHOWING THE GREATER CYLINDER WEAR AT THE ENDS
FIG. 2. METHODS OF MAKING THE JOINT; A, NOT RECOMMENDED; B, EASY TO MAKE AND STRONG

a safe rule in determining the diameter of the new rings being to allow 1/64 in. for each inch of the smallest diameter of the inside of the cylinder. For instance in Fig. 1, if the smallest portion of the cylinder at A measures 10 in., the diameter of the new ring should be 10/64 = 5/32 in. larger, or 10 5/32 in. diameter. This allowance insures a reasonable amount of expansion against the cylinder walls when the ring is forced into the cylinder, and also avoids a considerable amount of filing at the ring ends to make it fit the cylinder.

The Joint

THE break or opening cut in the solid ring to allow it to slip over the head, and for the purpose of fitting the ring, is made in a number of ways. Fig. 2 A shows a common method used to secure a continuous overlapping of the ring ends, but this has a decided tendency to weaken them. B however shows the most common and practical method of cutting the ring in one operation or cut, leaving a plain scarf lap opening, which is far easier to file in fitting the ring and in no way weakens the ring ends.

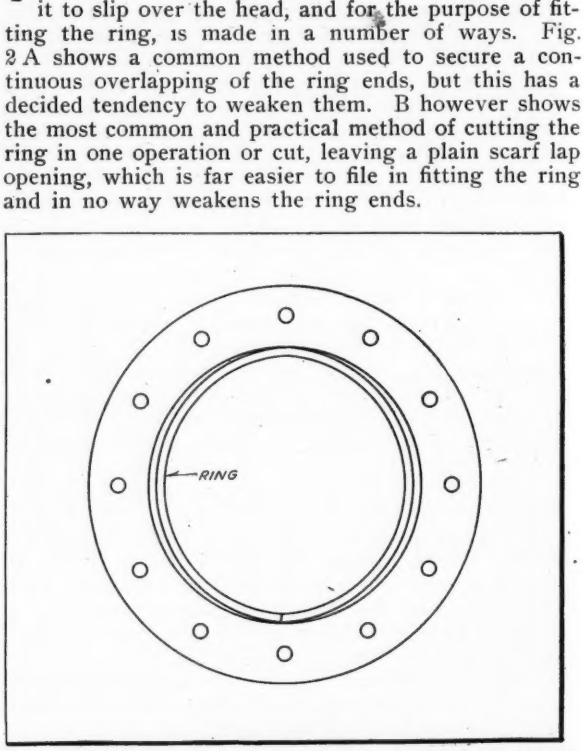


FIG. 3. ELLIPTICAL FORM OF RING WHEN SPRUNG TOGETHER

Figure 3 shows the elliptical shape into which the ring is forced when it is placed in the cylinder before fitting. It will be noticed that its contact with the cylinder occurs at only 2 places, namely at the belly of the ring and at the ring ends.

Filing to a Fit

ENDS of the ring should now be filed so as to allow but slight overlapping of the scarfed ends when the ring is placed in the central or least worn portion of the cylinder. This preliminary roughing off process can be done with a moderately coarse bastard file, but the final cut from the faces of ring ends should be taken with a file of the smooth or milled face class. While holding the ring in the vise to remove the stock at the ring ends, the face of the opening under the file should be close to the jaws of the vise, in order that the drag or cut of the file may not spring or break the brittle cast iron out of which such rings are generally manufactured.

The lower portion of the inside of the cylinder should now be smeared with a thin coating of lampblack. Now by crossing the arms and grasping the top of the ring with the thumb and fingers of the left hand, and holding the 2 ends of the ring together at

the bottom with the thumb and fingers of the right, the ring can be held in a rigid vertical position and pushed back and forth within the cylinder. By this process commonly known as spotting, the high points near the ends of the ring are readily detected by the lampblack which adheres to them as the ring is pushed through the cylinder. By filing these off and repeating the operation a number of times, it is an easy matter to file away the high portions of the ring ends quickly, and bring the remainder of the ring into perfect contact with the walls of the cylinder.

In order to prevent any possibility of a cramping of the rings in the grooves of the piston head at any part of the stroke, it is necessary that there should be not the slightest amount of overlap of the ring ends when the ring passes the center of smallest portion of the cylinder.

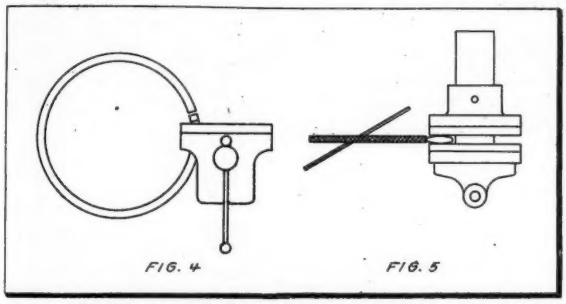


FIG. 4. PROPER POSITION OF RING IN VISE FOR FILING ENDS
FIG. 5. FILING THE ENDS TO MATCH

Ends of the ring can be filed accurately and with the faces accurately matching each other, by the method illustrated in Fig. 5. A smooth or milled file is held in the jaws of the vise by the tang. By grasping an end of the ring in each hand the faces of the openings can be drawn back and forth over the file, for the final operation of truing the ring ends, thus insuring a perfectly flat bearing of one end on the other.

Care is, of course, needed in doing the work, but with the hints given and patience, no trouble should be found in getting a satisfactory job.

FOR THE WORK of the Bureau of Mines, of whose value there is no need to present evidence, proper equipment is urgent as well as enlarged facilities. It is not only a question of securing better practice in using our fuels, but of saving the supply of fuel and metallic ores as well as lives of miners. At present both offices in Washington and laboratories in Pittsburgh are in crowded temporary quarters, and even now the laboratories are asked to vacate.

In the fuel field, the work includes besides that in the interest of economy in government purchase and use of fuel, investigations on the heat value of coals, their suitability for use in gas producers, value of briquets, lignite and peat, value of liquid fuels, and methods of smokeless combustion. Mining methods including removal and reduction of ore and safeguarding health and lives are subjects of careful, continuous study and report through bulletins that are furnished free to those who have use for them, but are not wasted broadcast.

As a mere matter of lessening the cost of operating government establishments, the Bureau of Mines is worthy of complete and adequate equipment and setting even a minimum of value on the assistance given to industries, the most lavish provision that could be asked would be a profitable investment for the country.

OHIO LICENSE REPORT

Work Done by the Examiners of Steam Engineers and the Boiler Inspection Departments During the Fiscal Year Ending Nov. 15, 1912

BY C. H. WIRMEL

NUMBER of applications for engineer's license, 2291; number of applications for boiler operator's license, 1410; total number of applications received, 3701. Number of engineers failing to qualify for license, 1149; number of boiler operators failing to qualify, 388; total number failing to qualify, 1537. Number of engineers qualifying for license, 1142; number of boiler operators qualifying for license, 1022; total number qualifying for license, 2164. Number of engineer's licenses revoked for cause, 3; number of engineer's licenses expired, 690; number of boiler operator's licenses expired, 271; total number of engineer's and boiler operator's licenses expired, 964. Number of engineer's licenses renewed, 12,775; number of boiler operator's licenses renewed, 1822; total number of licenses renewed, 14,597. Total number of engineers holding licenses to operate, 13,917. Total number of boiler operators holding licenses to operate, 2844. Grand total of engineers and boiler operators licensed by the department, 16,761. Total receipts from examinations and license renewals, $36,596.00. Total expense of maintenance of the department, $29,-557.23.

Fourteen employers and 18 operators were arrested and convicted for violating the law.

A census was taken of the steam plants in the First, Second and Seventh districts, which includes the cities of Cincinnati, Cleveland, and Toledo, by the Board of Steam Engineers' Examiners. The results derived from this census are manifested in the number of convictions secured against violators; the increased number of licenses issued, and the consequent increased protection afforded the public.

The law creating the boiler inspection department went into partial effect on January 1, 1912, but did not become fully effective until July 1, 1912. The following report covers an approximate period of about 7 months:

State inspections reported, 1980; insurance inspections reported, 11,670; boilers registered and certified, 12,150; boilers held for repairs, 302; boilers condemned and out of service, 198. Ohio Standard boilers built and approved since July 1, 1912, 702.

Fifty-nine boiler manufacturers were registered and authorized to build Ohio Standard boilers; of this number, 23 are Ohio builders and 36 are foreign concerns.

One hundred and seventy applicants took the examination in order to qualify as boiler inspectors; of this number, 146 qualified to act as such. From the list of those who qualified, 10 inspectors were commissioned to act as "general inspectors" in the service of the State, and 104 were commissioned to act as "special inspectors" in insurance service.

Three boiler explosions, in which 3 persons were killed and 1 injured, were reported. Four explosions which caused the deaths of 4 persons, and the injury of 11, occurred on boilers not covered by the law.

Total receipts from inspections, examinations, and certificate fees, $16,431.25. Total expenses of the department, $34,811.52.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

THE TWO-STROKE DIESEL ENGINE

A Working Stroke Each Revolution Giving More Power and Less Weight; the Method of Scavenging and Regulation

By Alfred Gradenwitz

ATTEMPTS recently made to utilize a given cylinder volume more advantageously than according to the 4-stroke process have resulted in the construction of 2-stroke Diesel motors. Whereas the 4-stroke motor requires 2 complete revolutions to yield useful work during one piston stroke, the 2-stroke motor gives a working stroke during each revolution.

It is true that the 2-stroke process entails the use of a special scavenging pump to discharge the exhaust gases. Four-stroke motors, which are slightly simpler from a constructive point of view, are therefore generally preferable for small and medium installations. In connection with large units, the addition of an air pump, however, is of much less importance, the more so as the pump discharging the scavenging air, works at very low pressures and accordingly under extremely favorable conditions. On the other hand, the reduction in weight is of paramount importance for large units, the frames bases and flywheels of large 4-stroke motors being so heavy that their transport and erection entail serious difficulties. Messrs. Sulzer Bros., of Winterthur, Switzerland, who have developed the 2-stroke Diesel engine, use it generally for outputs of upwards of 700 hp.

Special Features

THE 2-stroke Diesel motor resembles the 4-stroke type as far as its outside arrangement is concerned. The cylinders are likewise vertical; their jackets are cast of one piece with the frame, the working cylinders are encased and the piston is designed as crosshead. Apart from the compressed air pump which serves to introduce fuel oil into the cylinder and to start the engine, 2-stroke motors comprise a scavenging air pump arranged, in accordance with local conditions, in the basement or above the floor. The scavenging air valves, like the other valve, are arranged in the cylinder head. The exhaust valves are, however, replaced by slots in the working cylinder and the fuel supply is regulated automatically in accordance with the load on the engine. All motors of this type have

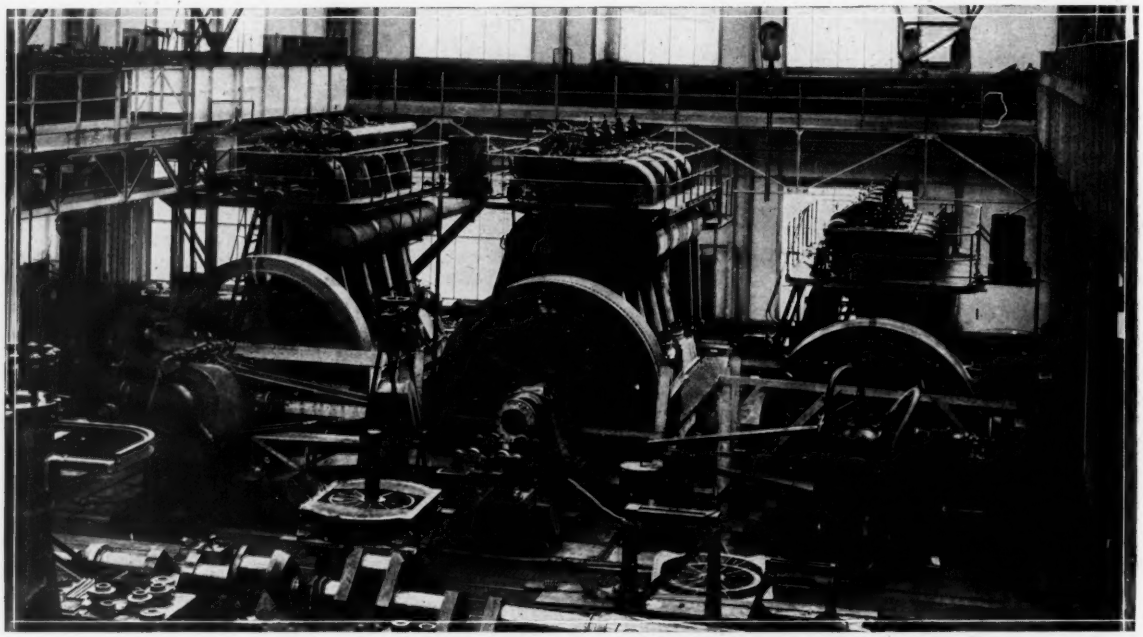


FIG. 5. TESTING FLOOR IN THE SULZER FACTORY, SHOWING COMPARATIVE SIZE OF 4-CYCLE AND 2-CYCLE DIESEL ENGINES

an attachment for changing speed during operation.

Figure 1 represents cross-sections of the working cylinder and head of a stationary 2-stroke motor. The arrangement of slots in the cylinder wall through which the exhaust gases leave the working cylinder, as the piston comes near the lower dead point, is, of course, a typical feature of 2-stroke motors. This arrangement is an undoubted advantage over 4-stroke motors, which discharge their exhaust gases through valves. The admission of scavenging and charging air is effected through 4 valves, arranged symmetrically in the cylinder head.

As seen from the figure, the piston comprises at its upper end a cooling compartment, pistons above a given size having to be cooled with water or oil. Telescoping tubes through which a water jet in free

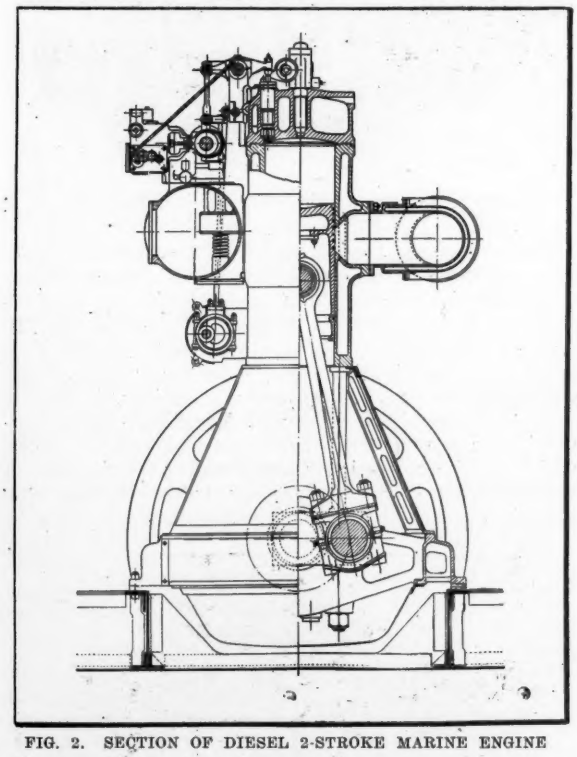


FIG. 2. SECTION OF DIESEL 2-STROKE MARINE ENGINE

contact with air is projected directly against the bottom of the piston, serve to admit and carry away cooling water, an arrangement which avoids any stuffing boxes.

Figure 2 shows a cross-section through a directly reversible Sulzer-Diesel marine engine which has likewise been designed as 2-stroke.

In connection with large units the special regulation developed by the constructors would seem to deserve more than passing notice. These engines are thus in a position to deal with any sudden fluctuations in load with least variation in speed and at the same time can be readily connected up in parallel with any other prime motors of the same or any different type, such as steam engines, gas motors and water turbines. The working of the regulator will be understood by referring to Fig. 3.

The governor controls, in accordance with its adjustment, all the factors on which the output of the engine depends. These factors in the case of Diesel motors are the amount of fuel injected, the amount and pressure of the injection air required for vaporizing and injecting the fuel, as well as the variable admission of the vaporizer valve in accordance with the amounts of air and fuel. The amount of

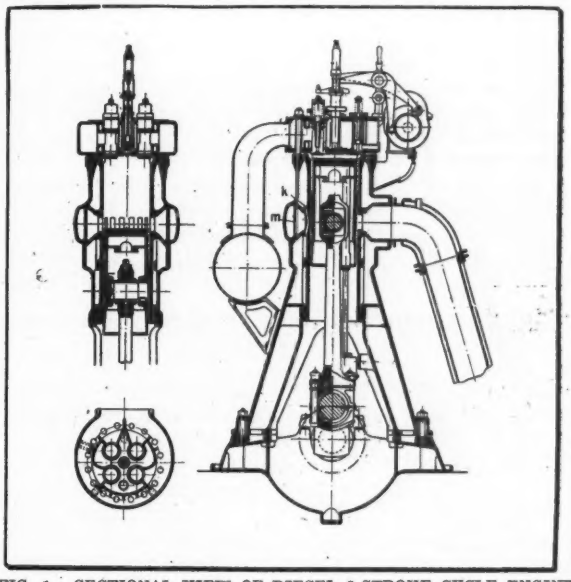


FIG. 1. SECTIONAL VIEW OF DIESEL 2-STROKE CYCLE ENGINE

fuel, as well as the amount of pressure of the injection air, are adjusted for directly from the regulator. The regulation of the amount of injection air in the present instance, is effected by adjusting a slide fitted into

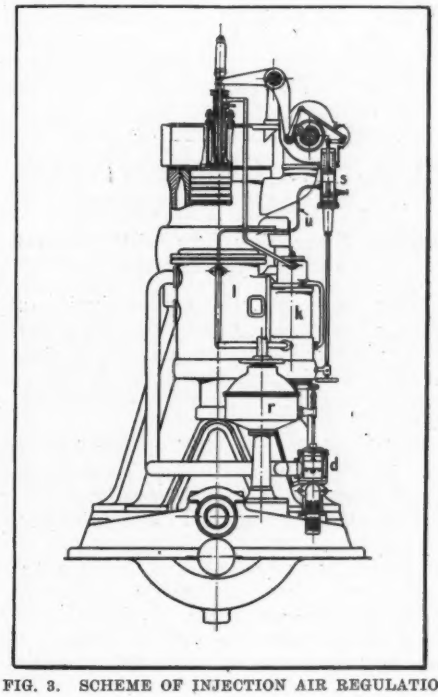


FIG. 3. SCHEME OF INJECTION AIR REGULATION

the suction conduit of the first stage of the injection air pump. The adjustment of the duration of opening of the fuel valve, on account of the valve resistance, however, requires much more energy, so that the action of the regulator itself would not be sufficient. A pilot valve S has therefore been provided which is operated by the pressure from one of the

stages of the injection air pump. In the present instance, the pressure obtaining between the first stage l and the second stage k of the injection pump is used for this purpose, the conduit u serving to transmit this pressure to the pilot valves.

The fuel consumption of a reversible Sulzer-Diesel marine engine is shown by Fig. 4. The flat shape of the curve distinctly shows that the fuel consumption, within large limits of energy, remains practically constant, which is particularly important for ships having to be operated at variable speeds.

Figure 5 finally shows a glimpse of the extensive testing plant at Messrs. Sulzer's works. To the left is shown an 800-hp., 4-stroke engine, to the right a 1200-hp., 2-stroke, and in the middle a 2400-hp., 2-stroke engine. This figure allows of a most instructive comparison between the relative dimensions of each type and strikingly illustrates the reduction in space requirements obtained by the 2-stroke process.

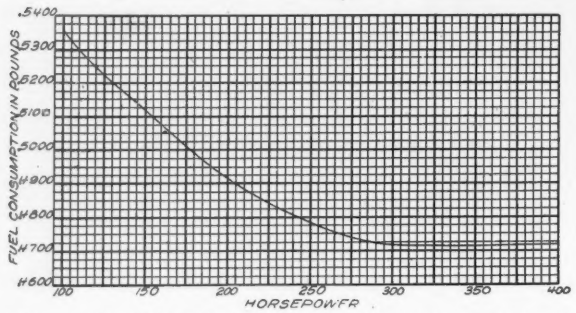


FIG. 4. FULL CONSUMPTION OF SULZER-DIESEL REVERSIBLE ENGINE OF 400 H. P.

Before being delivered, all motors are taken to the testing floor, there to be submitted to extensive tests for ascertaining the safety of operation, consumption of fuel, output, etc.

ELECTRIC CURRENT FOR SMALL PLANTS

New Gasoline Generating Sets with Vertical Automobile Type Engines

IN building these sets, the makers have sought to supply the increasing demand for simple generating units for isolated country estates, hotels, apartments, shops, mills and vessels of all sorts, to give satisfactory operation under the most trying conditions.

The multi-cylinder, vertical automobile type of engine has been chosen as the most suitable under the conditions, because of its reliability in hard service and the high state of development to which its design has been carried.

These generating sets consist of Sturtevant gasoline engines direct connected to electric generators. The engine is of the 4-stroke cycle, vertical, water-cooled type with 4 or 6 cylinders according to size. At present sets having capacities of 5, 10 and 15 kw. are being built.

The 4 cylinders of the smallest set are cast together, Fig. 1, with L shaped heads, enclosed valves and integral inlet and exhaust manifold and water jacket; while the cylinders of the larger sizes are cast in pairs with integral water jackets and T heads, with valves located on both sides. The camshafts with integral cams are driven by gears from the main shaft, the 5-kw. set having one camshaft, while the other sizes have 2 each. The base casting is in 2 sections split on the center line of the engine, the lower part containing the lubricating oil. A separate sub-base holding both engine and generator, is furnished with the 2 larger sizes, while with the smallest set the generator is overhung on the engine base.

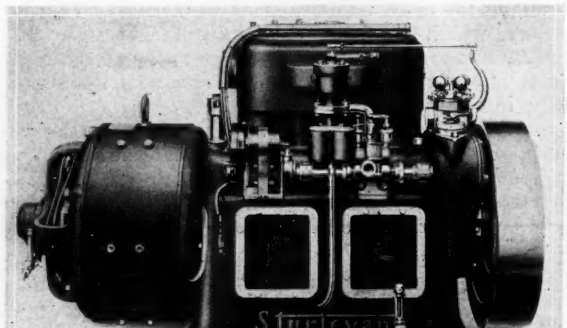


FIG. 1. 5-KW. GASOLINE GENERATING SET

The sets are throttle governed by means of governor of the centrifugal vertical type. The sensitiveness and close regulation of the governor are remarkable, no fluctuation in voltage from no load to full load, or from sudden variations of load, being noticeable, thus eliminating the necessity of operating through a storage battery as an equalizer.

Lubrication is positive and forced, oil being supplied by a pump to all the bearings, through a filter, which can be cleaned without drawing off the oil. A pump which circulates cooling water through the jackets is gear-driven from the crankshaft.

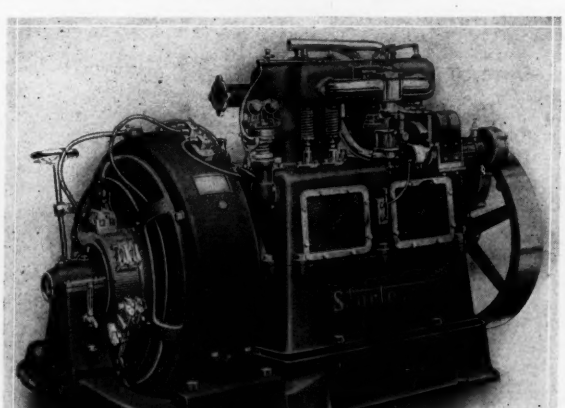


FIG. 2. THE 10-KW. GENERATING UNIT

Ignition is furnished by a Bosch high tension magneto driven by gears from the crankshaft, so that no battery is necessary for starting. A Sturtevant constant level carburetor is used in connection with a plunger fuel pump.

Both engine and generator are capable of maintaining an overload of 25 per cent for 2 hr. These sets are manufactured by the B. F. Sturtevant Co.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Use of Air Filters, Boiler Construction, Combustion in Gas Motor

By J. H. Blakey

CLEAN air is just as necessary for pneumatic machinery as clean water is for boilers. Pneumatic hammers, drills, riveters, etc., are found to wear out very quickly, as might be expected, when fed with dusty air, for the reason that all such air contains sand or other abrasive material which grinds the valves, cylinders, and all finished parts, and destroys their fit. The fact also that dust carries micro-organisms makes it desirable that the air supplied to refrigerators, brewers, yeast factories, laboratories, ice plants, butter and cheese factories, and all places where food is manufactured or prepared, should be as nearly dustless as possible. The same reasoning applies to air for heating and ventilating.

In France and Germany there are many large air filter installations, some of which are capable of delivering 100,000 cu. ft. of air a minute. They are constructed of a number of sheets of cloth of suitable texture, arranged on a framework fitted with springs to allow for the expansion and contraction caused by atmospheric changes. They will run day and night for 4 to 6 weeks. After that time the cloth must be cleaned. The first cleaning may be done by beating or by means of a vacuum cleaner; the second and subsequent cleanings, however, must be more thorough, which is generally accomplished by soaking the cloth in a chemical.

Large installations are furnished with an indicator which shows the difference of pressure on the 2 sides of the cloth. When the cloth is new, this difference of pressure is about the 1/10,000 part of an atmosphere. Consequently the indicator shows the condition of the cloth, and after cleaning will show very accurately how well this has been done.

Lessons to Be Drawn from Boiler Explosions

ACCORDING to a writer in the Bulletin of the Association of Boiler Owners of the North of France, 17 boiler explosions occurred between 1881 and 1906 as the result of cast iron being used in their construction. A number of these explosions were caused by the projection of the bottom of the boiler into a cast-iron base.

As the results of his observations in a large number of cases, the author recommends: 1. That cast iron should be absolutely banished in boiler construction. 2. That the bottoms especially should be of boiler plate. 3. That all lap joints should be treble riveted, in quincunx. 4. That all rivet holes should be drilled in place. Punching must be excluded.

The majority of boiler makers, continues the writer, in riveting the plates, punch to a smaller diameter and finish the holes with a drill slightly larger than the rivets, the consequence being that the body of the rivet does not completely fill the hole. In one case the cast-iron boiler head had come from the foundry with rivet holes larger than the rivets intended for it, and the reaming or drifting necessary to make the holes correspond had so weakened the plate as to cause the rupture.

This association has long recommended the replacement of all cast iron by cast steel. In France there are no government regulations regarding the construction of boilers, although both in Austria and Belgium a limit is put on the use of cast iron, and in Holland it is prohibited altogether.

In conclusion the author suggests the condemnation of those boilers in use having cast-iron heads, and if this is not practicable it would be proper at least to decrease the time between the visits of the boiler inspector as the boilers get older.

Influence of the Speed of Combustion on the Efficiency of a Gas Motor*

IN a preceding note the author has demonstrated a theorem which can be stated by the following practical rule, applicable to adiabatic motors:

If the maximum pressure is limited, by conditions of resistance, for instance, there is an advantage in pushing the compression preceding ignition up to this maximum pressure (if it is possible) and to produce combustion at a constant pressure.

But it is not always possible to operate thus. In the case in which the pressure in the cylinder is due to the compression of the gas previously mixed with the air, the elevation of temperature arising from the compression may occasion a premature ignition. This theory is founded on the supposition that the cylinder walls are absolutely impermeable to heat, which of course is never true.

The author has also demonstrated the advantages of instantaneous combustion, which seems to be in contradiction with the proposition stated above. This contradiction is only apparent, and the combination of the 2 propositions leads to the following theory; it is applicable however only to adiabatic motors:

1. If compression before ignition is not limited by any condition (for instance if the air and the combustible are compressed separately) there is advantage in pushing this previous compression up to the limit the cylinder will stand, then to produce combustion at constant pressure.

2. If certain conditions limit the compression before ignition, and if the pressure which the cylinder will resist is practically unlimited, there is an advantage in having an instantaneous combustion.

3. It can be demonstrated that if certain conditions (danger of premature ignition for instance) limit to p the pressure before ignition, and if the conditions of resistance limit to P the maximum pressure of the diagram, (P being greater than p but less than the pressure which would be developed by a complete instantaneous explosion) there is advantage in pushing the compression as far as p, then to make an instantaneous partial combustion to reach the pressure P, and finally to finish the combustion at constant pressure.

It is probable that these conclusions are equally true for real motors, in which the heat-conducting action of the walls is important.

*Note to the French Academy of Sciences by Mons. E. Merigeault.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

Magnetic Circuits, Magnetic Density and Magnetizing Force, Permeability, Ampere Turns and Electromagnet Proportions

IF a permanent magnet is laid on a horizontal surface, as shown in Fig. 1, and a compass is placed near the north pole the plane of the compass needle will assume a position in line with the longitudinal axis of the magnet. If the compass is moved away from the end of the magnet in a straight line a point will be reached where the needle will start to turn in one direction or the other and if the compass is moved in successive positions so that the needle assumes positions, as shown in the figure, the magnetic circuit through the surrounding medium at one side of the magnet will have been traced. Obviously an electromagnet or helix if connected to a source of current would produce similar results. Although a line of force leaving the north end of the magnet may seem to be straight and disappear in the air, sooner or later it will turn and return to the south pole.

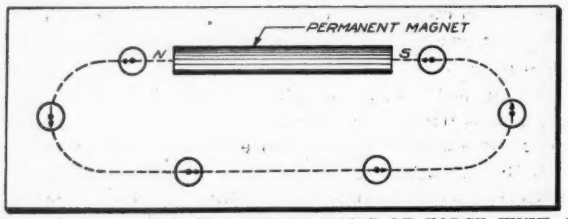


FIG. 1. TRACING THE PATH OF LINES OF FORCE WITH A COMPASS

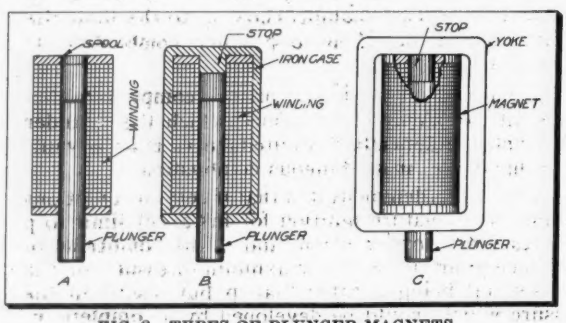


FIG. 2. TYPES OF PLUNGER MAGNETS

A solenoid through which a current passes sets up a magnetic flux in its center the lines radiating from the north pole and returning through the surrounding medium to the south pole; the density of this flux depends upon the number of turns of wire composing the solenoid and upon the current. If a piece of iron or steel is placed in the center of the coil the number of lines will be greatly increased as iron or steel offers much less resistance to magnetic flux than air. Let us refer to the Practical Reference Tables and look at the curves showing the relation between magnetizing force or magnetic density (lines per square inch), in air, H, and the magnetic density in iron and steel, B. Assume that we have a solenoid in which H has a value of 300 and that a core of gray cast iron is inserted in the center of the solenoid which completely fills the space. We now refer to the curves and from 300 in the horizontal row of figures at the bottom follow the vertical line upward until it intersects with the curve for gray cast iron, then follow horizontally to the left and in the vertical column of figures representing the values of B, we find approximately 42,500 as the number of lines of force that will pass through the iron core. If the core was a wrought iron forging or cast steel the value of B would be approximately 95,000.

It will be noted that B does not increase directly with H, as iron and steel reach a point where the increase in density is not proportional to the increase in magnetizing force, but rapidly falls off and the metal is said to be saturated when there is no appreciable increase in B with increase of H.

Now assume that the value of H in the solenoid be increased to 1100 then the value of B for gray cast iron will be approximately 65,000 as compared to 42,500 for 300 H. We have increased the value of H 3⅔ but H has increased only about 1½. It must be borne in mind that these values are only approximate as they vary considerably in different grades of iron.

From the foregoing we have seen that different mediums vary in the facility they offer for the passage of the lines of force, this facility is known as "magnetic permeability," for short, "permeability." The permeability of air is taken as one and that of soft iron may be 2000 or even greater.

Magnetic flux is the total number of lines of force passing through a given area of a magnetic circuit and is denoted by capital letter F, as shown in the Table of "Symbols and Formulas Used in the Calculation of Magnetic Circuits" in the Practical Reference Tables. A unit of flux density is 6.45 magnetic lines of force per square inch.

Formula (I) in the table, states that the magnetic density of iron or steel, B, is equal to the total magnetic flux, F, divided by the area in square inches, A. Assume that the total flux F in the core of a magnet whose area is 2 sq. in. is 100,000 lines, then the density B per square inch is $100{,}000 \div 2 = 50{,}000$. Conversely the magnetic flux in any sectional area is equal to the density in lines of force per square inch of area divided by the area of the magnetic circuit in square inches.

Permeability, as seen from formula (III), is denoted by the letter m and is equal to the magnetic density per square inch B divided by the magnetizing force or lines of force in air per square inch H. Assume that in the wrought-iron core of an electromagnet, B = 50,000 and H equals 330, then the permeability is equal to 50,000 ÷ 330 = 1515. The permeability decreases when the magnetic density B increases beyond a certain point where the iron or steel is said to be saturated; that is, an increase in magnetizing force does not perceptibly increase the magnetic density.

Strictly speaking, however, magnetic saturation never occurs within the practical limits used in standard practice. The practical saturation of annealed sheet iron and cast steel is between 110,000 and 130,000 lines of force per square inch and gray cast iron between 60,000 and 70,000 lines of force per square inch. The magnetizing force H is seldom carried above 1500 and may be anywhere between 0 and 1500. Annealing increases the permeability of iron and steel at low magnetic densities but above about 75,000 there is practically no gain.

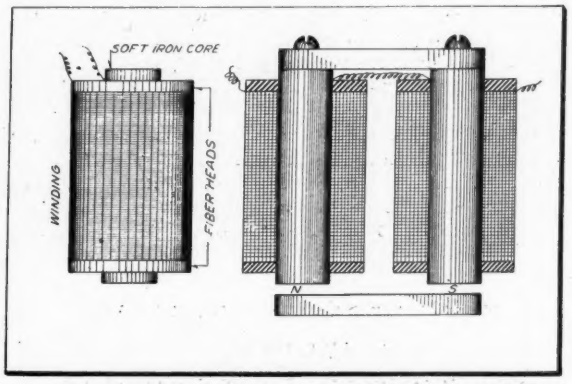


FIG. 3. MODIFICATION OF A HORSESHOE MAGNET

We have seen in our study of electric circuits that an electromotive force is necessary to cause a current to flow through the resistance of a conductor and the laws governing the magnetic circuit may be compared to an electric circuit. Thus, in magnetic circuits we have magnetomotive force comparable to electromotive force in electric circuits. Magnetomotive force may be defined as that force which produces magnetism or magnetizing force and is produced by a helix, through which a current passes. Corresponding to resistance in electric circuits is reluctance denoted by the symbol R which will be seen by reference to formula (V) in the Practical Reference Tables to equal the average length of the magnetic circuit divided by the product of the cross-sectional area of the magnetic circuit in inches and the permeability. Now by Ohm's Law current = Volts ÷ Resistance; in magnetic circuits, Magnetic flux = Magnetomotive force ÷ Reluctance.

Reluctance depends upon the length of the circuit, the sectional area and the permeability.

By ampere turns is meant the product of the number of turns of wire in a coil and the current in amperes, therefore it is obvious that one turn of wire carrying 100 amperes has the same magnetizing force as 100 turns with 1 ampere. The selection of the number of turns depends upon the service the coil is to perform, the current available, etc.

From formula (VII) we learn that ampere turns required for a specific purpose are equal to the continued product of a constant 0.313, the magnetizing force H and the average length of the magnetic circuit l. Assume that we wish to construct a solenoid with a magnetizing force of 1000 and the length of the air space within it is 6 in. then the required number of ampere turns is, $0.313 \times 1000 \times 6 = 1878$ a. t.

From formula (VI) we derive formula (VIII) which states that the magnetizing force H is equal to the product of a constant 3.192 times the number of ampere turns, divided by the average length of the circuit. Referring to the last example, assume that we wish to find the magnetizing force instead of the ampere turns, then $H = (3.192 \times 1878) \div 6 = 998$. Had the decimal places been carried out indefinitely the answer would have been 1000 corresponding to the magnetizing force.

Assume that under these conditions we insert a piece of soft gray iron in the solenoid to fill the air space completely, what would be the magnetic density? Referring again to the curves showing relation between magnetizing force and magnetizing density we follow the vertical line upward from 1000 H to the intersection of the curve for soft gray iron, then follow to the left and find that the magnetic density in the iron is approximately 64,000.

Refer to the Ampere Turn and Saturation Curves for Different Qualities of Iron and Steel. The horizontal row of figures at the bottom indicates the number of ampere turns for each inch of length of the magnetic circuit and the vertical column of figures the density in lines of force per square inch area of the magnetic circuit.

How many ampere turns per inch of length will it require to produce 100,000 lines of force in a wrought-iron bar 1 in. square and 6 in. long? From 100,000 in the lefthand column follow the horizontal line to the left until it intersects with the ampere turn curve for wrought-iron forgings, then follow down the vertical line to the bottom where we find 130, the number of ampere turns required per inch of length, then $6 \times 30 = 180$ = total number of ampere turns required.

Permeability curves marked m are also shown. To find the permeability of wrought iron at 100,000 lines per square inch, follow the horizontal line to the right from 100,000 until it intersects the permeability curve and read 225 in the horizontal row of figures at the top.

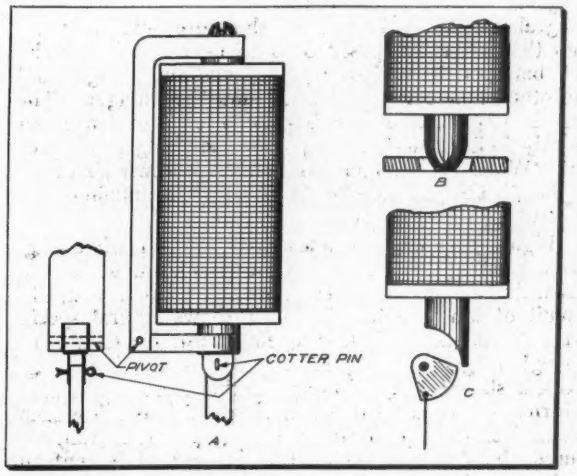


FIG. 4. SPECIAL TYPES OF MAGNETS

The permeability curves represent the degree of saturation; up to about 40,000 lines per square inch the permeability of annealed sheet iron, wrought iron and steel increases rapidly but falls off from that point and reaches a minimum at from 110,000 to 125,000, and at about 65,000 for gray cast iron.

Proportions of Magnets

ELECTRO-MAGNETS are proportioned to give a certain pull in pounds, this pull being proportional to the ampere turns and the area of the core in square inches for various air gaps as shown by the curves giving the relation between pull in pounds per square inch air gap and ampere turns.

For example if we wish to design a magnet to exert 50 lb. pull with ½ in. air gap, follow the vertical line from 50 lb. in the horizontal row of figures at the bottom, upward until it intersects with the curve representing ½ in. air gap, from here follow to the left on the horizontal line and read 10,500 the required number ampere turns. This is for rough calculations, the theoretical design will be taken up in a future article.

The proportions of electromagnets depend upon the class of work for which they are designed, the length of a plunger magnet being determined by its range of action and the pull of short range magnets by the area of the core. In general the outside diameter should be about 3 times that of the plunger and the length should, where possible, be at least 2 to 3 times the outside diameter.

In a plunger magnet the range of action is directly proportional to its length regardless of the ampere turns, in the open magnetic circuit type shown at A, Fig. 2, the pull is exerted between the winding and the core and since the flux density is greatest at the center, the pull will also be greatest at that point.

Owing to the great reluctance of the magnetic circuit in this type of magnet, on account of the long path of the flux through the air, it is suitable only where small force is needed. To reduce the reluctance of the magnetic circuit, plunger magnets are made iron clad so that the magnetic circuit is composed entirely of magnetic substances when the plunger is drawn up into the magnet, with the exception of the small air gap around the plunger at the bottom side and between the plunger and stop.

Another form of plunger magnet is shown at C in which the iron case is replaced by a yoke. It is customary to provide a stop at the top which is generally made integral with the yoke or case, therefore, with such design the pull is composed of 2 components; one is the pull between the end of the stop and the plunger and the other that between the coil and the plunger. The first is important at the beginning of the stroke but quickly falls below the coil pull as the plunger is drawn out. When the plunger has been withdrawn about 0.6 its length the pull rapidly decreases to the minimum as it moves toward the bottom of the coil.

Figure 3 shows a modification of the horseshoe magnet consisting of 2 electromagnets attached to a cross bar which with the armature forms a continuous magnetic circuit of low reluctance; Fig. 4 shows several special types of magnets. It is frequently desirable to use but a single magnet and a good arrangement for short range work is shown at A. To increase the range of a magnet 2 forms of cores and armatures shown at C and B suggest themselves; in both forms the air gap is materially reduced thereby securing a stronger and more uniform pull and wider range.

The form shown at C is best adapted for a single magnet the quadrant shaped armatures being substituted for the flat armature in the form of construction shown at A. The arrangement shown at B is suitable for the double or horseshoe magnet in Fig. 3, conical holes being drilled into the armature to receive the elongated cone-shaped ends of the cores.

NOVEL TURBINE INSTALLATION

Six Thousand Horsepower Turbines Driving Direct-Current Generators, Reducing Gearing, the Largest Ever Built

TWO sets of machines are being furnished by the Westinghouse Machine Co., of East Pittsburgh, Pa., to the Cleveland Electric Illuminating Co., which are not only noteworthy in their application, but interesting in their combination. Each set of apparatus consists of a 6000-hp. steam turbine, a 6000-hp. direct-current generator and a reduction gear of corresponding capacity.

The steam turbine, running at a speed of 1800 r.p.m., drives the generator, which runs at a speed of 180 r.p.m. This is made possible through the interposition of the reduction gear, which equalizes the speed of the entire combination. The unit represents the largest direct-current generator that has ever been built for turbine drive, as well as the largest turbine driven gear ever built.

Six thousand horsepower in electric current is developed, which the company supplies for lighting in the downtown part of the city as well as for the electric railway system. Another interesting feature is that the exhaust steam is used for heating purposes in nearby buildings.

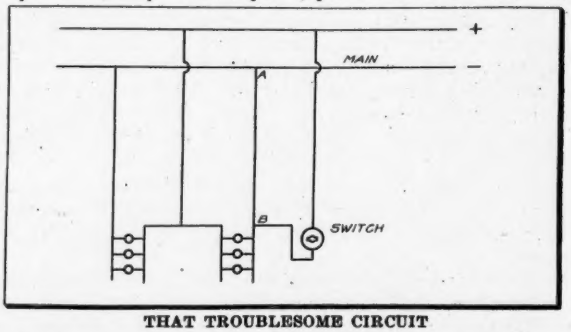
TROUBLESOME LIGHTING CIRCUIT

Cause of the Trouble and How it was Located

By T. G. Thurston

THE telephone bell rang, and upon picking up the receiver, the genial voice of one of my engineer friends greeted me. He was having trouble with some wiring he had just installed and calmly informed me that the fuses would blow when he opened the switch. When I recovered from this astonishing bit of information I suggested he might be mistaken but he was absolutely sure of his point and asked me to come over at the earliest opportunity and see if I could solve the mystery.

When I arrived on the scene the lights were on and my friend, to prove his point, proceeded to switch them



THAT TROUBLESOME CIRCUIT

off and sure enough when he turned the switch, out went the lights. With a superior Sherlock Holmes air, I proceeded to disconnect the switch and take it apart, informing my friend that it was a simple case of short circuit in the switch. He succeeded fairly well in suppressing a grin of amusement and did not venture to contradict my statement; he failed also to mention that he had proceeded on this theory himself and had found, the switch O. K., so he waited for a good laugh, at my expense and he got it.

When I had the switch apart and found it O. K. I was stumped. Leaving the switch disconnected I opened the main switch in the fuse cabinet and replaced the fuses. Now if my friend's diagnosis was correct the fuses should blow when the main switch was closed, seeing the troublesome circuit was open by being disconnected at the switch, nothing happened however.

Coming back to the room where the troublesome circuit and switch were located a new mystery presented itself, the lights that should have been out, as the circuit was open at the disconnected switch, were burning Now a switch that will blow fuses when it is opened is bad enough but lights that will burn on open circuit are about the limit. The trouble evidently was not in the switch so I began to investigate his connections, which was quite a proposition.

The wires were run in moulding and several clusters that branched off the main, were controlled by the main switch in the fuse cabinet, the only exception was the one on which he was having his trouble for which he desired a separate switch. In trying to save wire he had made several ingenious connections which I tried vainly to figure out by inspection. I finally made a sketch of the connections and after eliminating all but the essential parts I found he had connected the troublesome switch and circuit as shown in the diagram.

I cut out the section A B of the circuit connected the switch again and everything was rosy. Inspection of the switch disclosed the fact that what my friend thought was the open position of the switch was the closed position, hence when he closed the switch he had a dead short circuit across the main and of course the fuses went.

ELECTRICALLY OPERATED BRIDGE

Description of Equipment at Portland, Ore.

IN laying plans for the installation of a drawbridge for Hawthorne Ave., Portland, Oregon, the city officials endeavored to eliminate the many vexatious delays that were due to the constant opening and closing of the old draw span type Madison Street bridge which formerly occupied approximately the same location as the present structure.

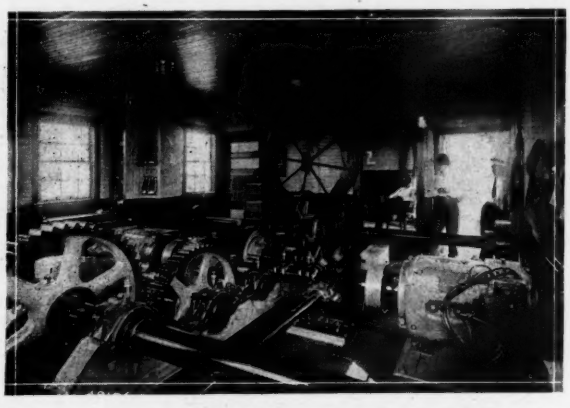


FIG. 1. INTERIOR VIEW OF MOTOR HOUSE SHOWING MOTORS AND GEARS

After looking over the various types offered they finally decided on the lift span type as being the one which would most effectively alleviate these conditions. This has proven a very wise selection on the part of the city officials, as the time required to raise the bridge to the top of the span and lower it is less than that required to swing open the draw span type The lift span type however, possesses an additional advantage in that it is unnecessary in most cases to raise the span more than a few feet to accommodate the greater bulk of the river traffic, and consequently the delays to traffic across this bridge have been reduced to a minimum.

This type of span resolves itself, from an operating standpoint, into practically an elevator proposition, the weight of the span being balanced by means of large concrete counterweights connected to the span by means of steel cables operating over sheaves located at the top of the towers on either side of the span.

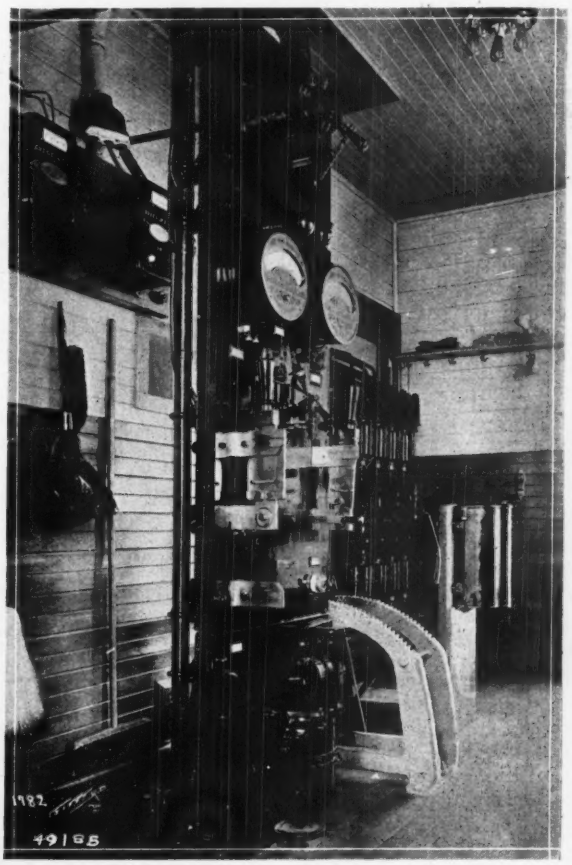


FIG. 2. DRAW PANEL AND OPERATING MECHANISM FOR MOTOR CONTROL

The bridge is operated by means of 2 No. 160 Westinghouse 125-hp., 550-volt, direct-current railway crane type motors, which are directly coupled to a train of gears located in the machinery house on the top of the span, this reduction gearing, in turn, operates the bridge by means of steel cables. The lift span is guided in raising or lowering, by means of steel roller bearings operating in the guides located in the vertical uprights of the towers.

The bridge was designed by Waddel & Harrington, consulting engineers, Kansas City, Mo., and was erected under the supervision of Mr. Leon Clarke, engineer in charge of electrical equipment, including the motors and control equipment was furnished by Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

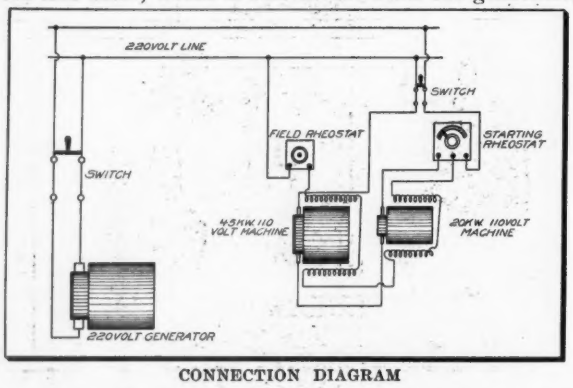
ELECTRICAL CORRESPONDENCE

POWER PLANT PROBLEM

AT the plant where I am employed we have one 300-kw., 220-volt generator, also one 45-kw., 110-volt generator. The 220-volt machine is direct connected to a 600-hp., cross compound Corliss engine, we use a belt to drive the 45-kw., 110-volt machine, also a line of shafting. Everything in the plant is driven from the 220-volt machine with the exception that the 110-volt machine drives one 20-kw. motor and some lights.

I should like to know if I can take this 110-volt generator and run the line of shafting off the 220-volt machine, and if it could be run in series with this 20-kw., 110-volt motor, or if this is not possible, if you will show us some way to use these 2 machines off the 220-volt circuit. We would use 220-volt lamps, as we have the power to spare from the 220-volt machine. Do you know of any transformer for reducing from 220 to 110 volts? Having these machines on hand we would like to use them; they are G. E. machines, compound wound. J. J. H.

A. You have a very pretty problem in power transmission in your plant, and I think it can be done successfully but will need some precautions taken. There is no way, so far as I see, of telling what power the line shaft, which is belt driven from the generator,



CONNECTION DIAGRAM

is taking. You can, of course, get approximately what it might take from the width of the belt, diameter of the pulley, and the number of revolutions.

If you put the 20-kw. motor and the 110-volt, 45-kw. generator in series, then both machines would have to take the same amount of power. They would run all right in series but it would be better to connect the two fields in series with each other directly across the 220-volt mains rather than having each field in parallel with its own armature. The compound winding would, of course, be thrown out in the 45-kw. generator when it was used as a motor.

Besides the question of power used on the line shaft there comes also the question of speed. Probably you would have to belt this 45-kw. machine to the line shaft and before you could tell what speed it would run at under the new conditions you would have to try it connected up in series with the 20-kw. machine. You could make this test at no load and the speed would be but little less at full load than at no load.

The connections would be approximately as shown in the illustration. I have omitted all the instruments, and circuit breakers, showing merely the rheostats, starting box and switches.

The only way that you could go from 220 to 110 volts by a transformer would be the introduction of a rotary converter, assuming that you have direct current, and this would cost you more than replacing the two 110-volt machines by 220-volt motors. A. L.R.

LAMPS AND MOTORS ON A. C. CIRCUITS

PLEASE explain the connections of 2- and 3-phase induction motor of the squirrel cage type, for 220 or 440-volt circuits. Can I take current from any of those circuits for lighting purposes by the use of a transformer? We wish to use Mazda lamps in clusters for inside and arc lamps for outside lighting. J. McC.

A. You probably understand that the winding for the armature of a squirrel cage motor is simply a lot of bars put through the armature and connected at the ends by a ring. It is not a very efficient motor and ordinarily is used only for small powers.

There is no difficulty about taking lamps off a 220-volt circuit, as the Mazda lamps are made for this voltage. The only thing that would need caution is that the lights be so distributed on the different legs of the circuit as to balance the load, that is, have about the same number of lamps burning on each side of the circuit at all times.

Arc lamps are made for 220 volts but are not efficient. It would be better to use 2 110-volt lamps in series if it were possible to arrange it in this way.

The field winding for an induction motor consists of a number of flat coils wound into the slots of the field frame, and for a 2-phase motor connected in 2 circuits, for a 3-phase connected in 3 circuits. In the case of a 2-phase motor one series of coils is connected into each phase; in the case of a 3-phase motor the 3 series of coils are interconnected so that 3 terminals are brought out and the 3 terminals of the line are connected to these 3 motor terminals. If the motor runs in the wrong direction, interchange the connection of 2 terminals. A. L. R.

JUMPER FOR ARMATURES

IF one armature coil burns out how can I insert a jumper? A. O.

A. Putting a jumper on an armature coil depends on the winding of the armature. If it is what is known as a lap wound armature, so that the two ends of the coil connect to commutator bars which are adjacent, putting on a jumper means simply making a connection between the 2 bars to which the coil is connected.

If it is a wave winding, it will be necessary to find the 2 bars to which the coil is connected, put a connection between these 2 bars to take the place of the burned-out coil.

Of course, the armature should be run with jumper on no longer than is necessary, because such a connection is liable to make trouble and at any rate unbalances the voltage in the different armature circuits. A. L. R.

BATTERIES FOR BURGLAR ALARM SYSTEM

WILL you kindly inform me the kind of batteries to use on a closed circuit relay burglar alarm system? J. P. M.

A. The best battery to use on a closed circuit system is what is known as the gravity cells or the sulphate of copper battery. This is a solution of sulphate copper and water, giving a blue fluid, and has a crow-foot of zinc in the top of the jar for one electrode, and a crow-foot of copper in the bottom of the jar with an insulated wire running down to it for the other electrode. There are some crystals of sulphate of copper in the bottom of the jar. You can get these batteries of any electrical supply house. A. L. R.

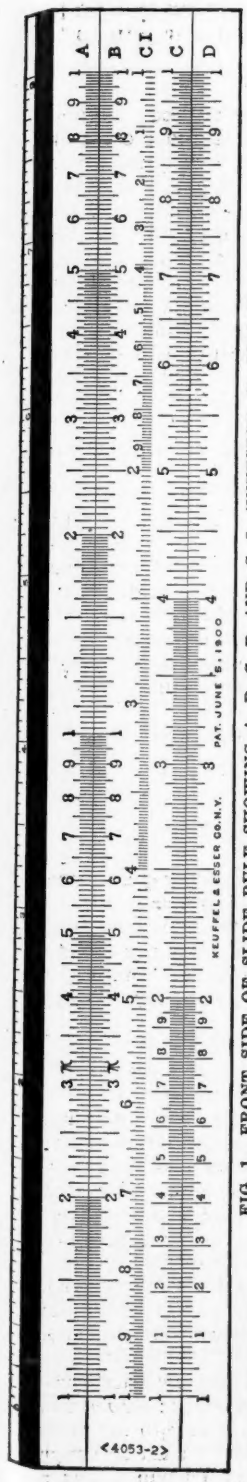


FIG. 1. FRONT SIDE OF SLIDE RULE SHOWING A, B, C, D, AND C. I. (INVESTED C) SCALES

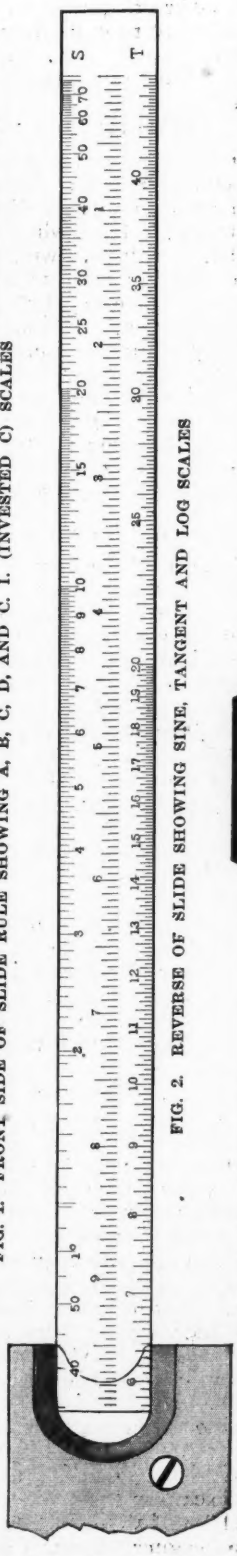


FIG. 2. REVERSE OF SLIDE SHOWING SINE, TANGENT AND LOG SCALES

FIG. 3. LOWER EDGE OF RULE SHOWING CUBE SCALE

THE SLIDE RULE FOR WORKERS

Living Experience from the Man Who Has Found That It Saves Time and Brain Drudgery in Daily Power Plant Calculations of Coal Weight, Meter Readings and Pump Duty

By H. L. Sherman

I WANT to have a heart to heart talk with ten thousand engineers and power plant workers.

I hope to show them a way that as it is followed opens a wider field of knowledge. I want to add my word of praise for the slide rule, to tell how beneficial is its use, how it eases the burden of figuring mechanical problems, lessening the labor involved, thereby encouraging its use in more complicated questions, and leading its user to consideration of things that would have been beyond him but a short time before.

It is a stimulator of ambition; its use gives a confidence born of knowledge, which replaces hesitation and doubt.

Many years ago, while I was a machinist apprentice in a small job shop in a New York State town, I was one of a small class of night school pupils in drawing. Two Englishmen were there, one of them the teacher. The slide rule was discussed and from what I can remember I received the impression, and one that I still hold, that use of a slide rule by British and German mechanics is quite common. About 5 yr. ago while working on the erecting floor in the shop of one of our great engineering firms, none of my shop mates seemed to know what a slide rule was. So I can only conclude that we are not grabbing every good thing in sight as we so fondly imagine.

From the time I heard the slide rule discussed as an apprentice, for 20 yr. I do not remember seeing one. The first one was in the hands of a Swedish erecting engineer. He was a beginner and was figuring the areas of circles with one. About this time I became interested in the study of surveying, and to find some easier way to solve the intricate problems in trigonometry, I got a 10-in. slide rule and began its study. I am no spring chicken, and in looking over my past life, I can remember no more interesting thing since I learned to skate on rollers. I wish to say here that a neighbor, who had been successively a soldier, shoemaker, farmer and surveyor, and who is now a county engineer, started me in my studies and very kindly gave me the benefit of his experience and advice. Before the summer was over my surveyor friend used to bring me field notes to check for him when the plots would not close. I could figure the latitude and departure of the courses while you wait. For several years I have had no occasion to do this kind of work, so will try to show some of the everyday problems that I find it convenient to run through the rule and ask it the answer. It always tells the truth if I do my part.

First Principles

TO start with, you can multiply, divide, work proportions, which is both, extract square and cube root, or in fact any root, and perform many calculations in trigonometry. In short, it is said that anything can be done with a slide rule that can be done by the use of logarithms. This is true within the limits of the rule, or a 10-in. rule may be compared to a table of 3-place logarithms.

I understand that the slide rule was the invention of a German artillery officer. I am willing to bet that

his idea was to get a scheme for finding how near (or is it far) the enemy was—that is, the range—before they had time to eat their breakfast, pick their teeth and saunter out of range. Or perhaps when they came too close, the German wanted to saunter a few himself.

I have before me the 10-in. Manheim slide rule that has been my daily companion for 10 years. It is as good as ever and I see no reason why, with reasonable care, it will not last another lifetime after I am through with it.

There are on the rule 4 scales. Starting with the upper righthand corner, the scale on the rule is A, and on the slide is B.

The lower scale on the slide is C, while the lower scale on the rule is D. On the opposite side of the slide is the scale of sines above and tangents below, and on the latest forms a scale of logarithms in the center. Also on some forms an inverted C scale is in the center of the front of the slide, and on the lower edge of the rule is a scale without index letter which is ⅓ the C scale or shows the cubes of the divisions on C.

If you will look at the lower front scales, you will see that the first lefthand figure is one, reading across from left to right, from 1, 2, 3, etc., to 10. On the

$$\frac{1156 + 144.5}{[(8.5 \times 34 \times 4) + (4.25 \times 34 \times 1)] \times 50 \over 2000}$$

$$1156 + 144.5 = 1300.5$$

$$\frac{1300.5 \times 50}{2000} = 32.5 + \text{TONS}$$

FIG. 4. ARITHMETICAL OPERATIONS FOR CALCULATION OF WEIGHT OF CAR OF COAL

upper front, A and B, are other scales just one-half as long, duplicated; or in other words, the upper scale should be given the value of 1, 2, 3, 4, etc., to ten, then 10, 20, 30, etc., to 100. In other words, 1 = square of 1, while 100 = square of 10; that is, every number on the upper scale is the square of the number on the lower scale, and every number on the lower scale is the square root of the number on the upper scale.

You will notice that, if you add the length marked 2 on the scale to 2 on the slide, under 2 on the slide find 4 on the rule, or the combination of 2 lengths gives the product instead of the sum; hence, the rule put 1 over the multiplier and under the multiplicand find the product. As division is the reverse of multiplication, place the divisor over the dividend and under 1 find the quotient.

The best practice I can suggest is first to try the multiplication table. One over two—under two find four; 2×2=4; then 2×3=6, etc., until we reach 2×12 =24. Then try 3×2, etc., up to 3×12=36. Now we have gotten somewhere.

Where Is the Decimal Point?

IF the slide projects to the right, there will be as many figures in the whole number of the product as there are in the multiplier and multiplicand, less one. If the slide projects to the left, there will be as many as in the multiplier and multiplicand.

The above are about the rules given in the text book, but the student will soon forget this rule. When he commences to figure how much coal there is in a car, he will know before he starts somewhere near what the answer should be.

Practice and learn to read your rule and you will have no occasion to read any intermediate results nor will you hesitate as to where your decimal point belongs. You will know by inspection ninety times out of ninety-eight.

A Carload of Coal

A FEW days ago we received a car of coal. To get an idea about the weight, I measured the car and estimated the heap on top. Width was 8 ft. 6 in., length 34 ft., depth 4 ft., while on top it was piled about 1 ft. high. Our coal weighs loose about 50 lb. per cubic foot, and, by the way about 93 lb. in the solid in the mine. The calculation is shown in Fig. 4.

In performing this calculation, set righthand 1 on C at 8.5 on D and bring the runner to 34; bring righthand 1 on C to runner; runner to 4 on C and below on D find 1156. In like manner, multiply 4.25 × 34 and get 144.5. Add these, giving 1300.5 and bring 1 on C to 13005 on D and runner to 5 on C, which performs the multiplication; bring 2 on C to the runner and under 1 on C find 32.5 on D; this performs the division.

Checking Daily Operation

I USE a slide rule in checking water meter reading in this way. Manufacturing company meters usually run about the same one month with another; if 8 days have elapsed since the last reading, then water consumed divided by the number of days, multiplied by the number of days in the whole month, multiplied by the rate, gives a probable estimate of what the month's bill will be, and tells you whether or not the meter needs cleaning.

If a reading for 8 days shows 50,000 gal. and the rate is 6 cents per 1000 gal., the estimate of monthly bill would be:

$$\frac{50 \times 30 \times 0.06}{8} = \$11.23$$

The multiplications and division being performed in the same manner as for the previous example.

I use it to figure fractional hours in making out small pay rolls. If it should cost 18 cents per foot to dig trench and lay 4-in. pipe, and I have 7 men at $2 a day, how many days will it take me to lay 800 ft.? The calculation is:

$$\frac{800 \times 0.18}{7 \times 2} = 10.25 \text{ days.}$$

This is a better estimate than I could give by guessing.

I figure each day number of strokes of pump, water pumped in gallons, amount of coal consumed and cost, and cost of water pumped per 1000 gal. This is a general check on the efficiency of the plant. Sometimes we meter our feed water, and the pounds of water pumped, divided by the weight of coal, gives a test on the evaporation or check on the fireman, coal, furnace and boiler. Also I figure pump duty and amount of water consumed per hour per indicated horsepower.

I figure how much material in cubic yards there will be if I am going to do a concrete job; how much cement, sand and gravel each I am going to use; and how much excavating there will be. I used to figure question relating to the flow of gases when I was a gas pumping engineer. In short anything that I want to know I make a stab at it and fuss away until I have it clear with the aid of the little old slide rule.

MECHANICAL EQUIPMENT OF A MODERN HOSTELRY

(Continued from page 211)

exposed wall. This room is heated by one radiator with 25 sq. ft. of surface; the contents is 1760 cu. ft., providing 1 sq. ft. of radiating surface for 70 cu. ft. of contents. The difference in ratios shows the extra allowance for outside rooms.

Risers

THERE are 27 supply risers and 27 return risers extending from the basement to above the ceiling of the eleventh floor. Fig. 7 shows the standard base for the supply risers which is controlled by a ¾-in. gate valve and a Webster motor valve. The dimensions

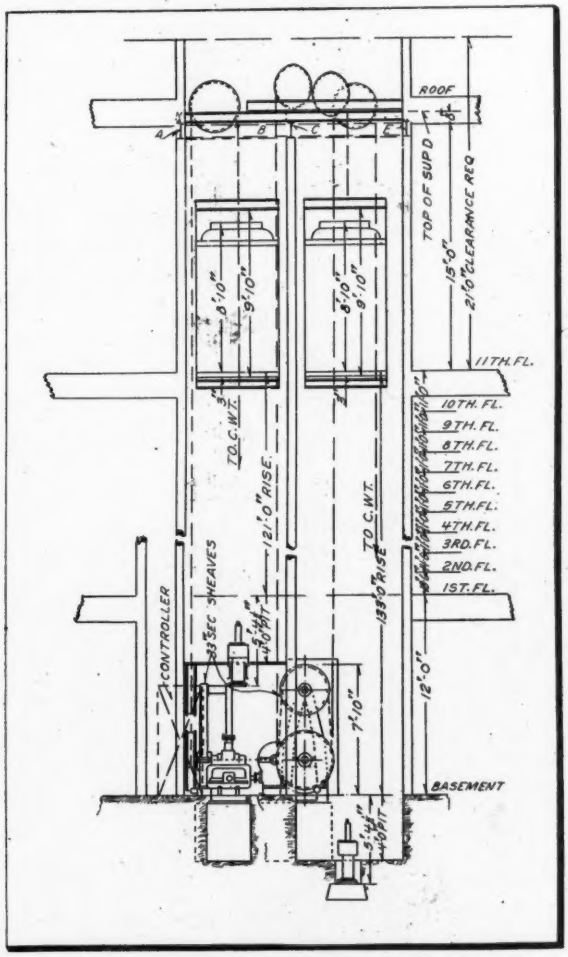


FIG. 8. SECTIONAL ELEVATION OF 2 ELECTRIC PASSENGER ELEVATORS

of a typical supply riser and a typical return riser are: Supply riser, which feeds downward, first to second floors, ¾ in.; fourth to sixth floors, 1½ in.; sixth to seventh floors, 2 in., seventh to pent house floors 2½ in. Return riser, first to fourth floors, 1¼ in.; fourth to tenth floors, 1 in.; tenth to pent house floors, ¾ in. The entire steam, electric, heating and ventilating system was installed by the contractors, The Edward Joy Co., Syracuse, N. Y.

Elevator Equipment

THE elevator installation comprises 2 electric worm gear traction passenger elevators; one electric drum type freight elevator; one electric drum type service elevator, one hydraulic plunger ball room elevator; one hydraulic plunger trunk lift; one hydraulic plunger freight elevator; one hydraulic plunger ash lift and one hydraulic plunger bar lift, all manifactured by the Otis Elevator Co.

Electric Elevators

FIGURE 8 shows a sectional elevation of the 2 electric worm gear traction passenger elevators, which operate in the same hatchway with the electric passenger elevator machines of the duplex worm gear type located in the basement, each being driven by a 25-hp., 220-volt d.c. motor.

These elevators are designed to lift a maximum load of 2500 lb. and to travel at a speed of 300 ft. a minute with a load of 2000 lb. The elevators are

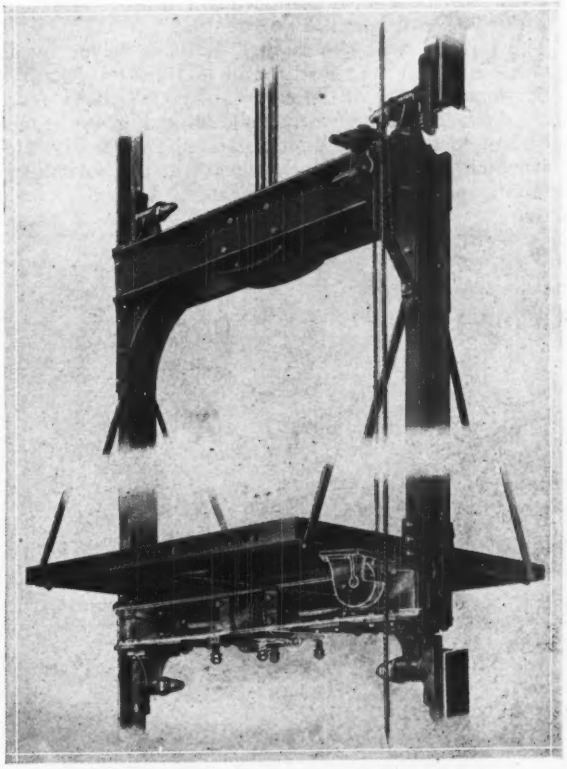


FIG. 9. ELEVATOR SAFETY DEVICE

operated by means of a switch in the car, through which the operator governs the direction magnets in the controller, the direction of travel only being determined by the operator; the acceleration and the speed are obtained automatically after the up or down circuit has been made.

The method of driving the car is similar to that in use in connection with all traction type elevators; the cables fastened to the car pass over the overhead sheaves down to and around the driving sheave, half around an idler sheave mounted above the driving sheave, again under the driving sheave and over the overhead sheave to the counterweight. With this arrangement, should the tension on the cables be suffici-

ently relieved, the driving effort of the machine will be minimized until the normal conditions have been resumed.

These cars are approximately 4 ft. 11 in. wide and 5 ft. 11 in. deep. In addition to the regular safety devices installed in this type of elevator, emergency levers have been provided, which permit the operator to stop the car mechanically in emergencies.

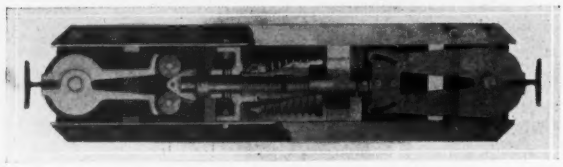


FIG. 11. PLAN VIEW OF SAFETY PLANK

These elevators as well as electric freight elevator and electric service elevator are equipped with a speed governor, releasing carrier and wedge clamp safety device to prevent higher than normal velocities. The wedge clamp is mounted underneath the car and the governor is located at the top of the shaft.

The governor, as shown in Fig. 10, is driven by a rope made fast to the elevator and rotates at a velocity proportional to that of the car. The rope travels over sheaves attached to the car, as shown in Fig. 9, thence around the drum of the safety plank shown in Fig. 11, from which it passes around a sheave at the bottom of the shaft and returns to the elevator. Under normal

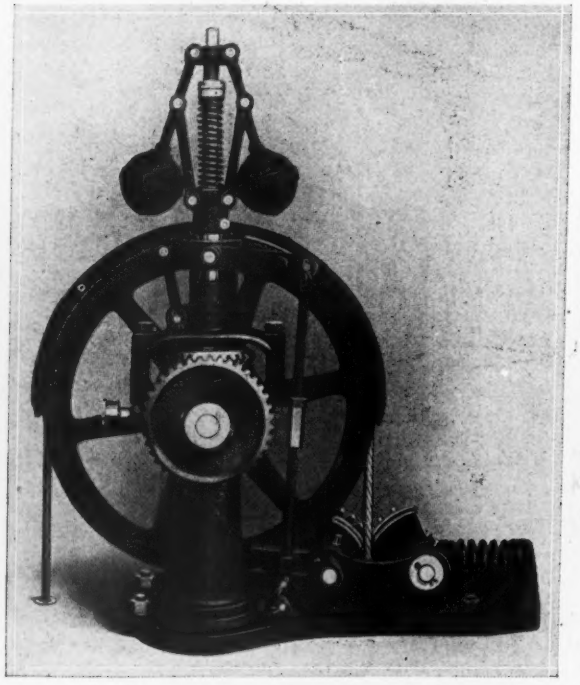


FIG. 10. ELEVATOR GOVERNOR

running conditions the governor is revolved by the rope passing over the drum of the safety plank, friction being sufficient to prevent the drum turning.

At the governor, the rope passes between clamp jaws and, when the car exceeds a predetermined speed, the governor actuates these jaws causing them to grip the rope. This in turn causes the drum of the safety plank to revolve on a right and left hand threaded shaft, made in 2 sections, forcing the wedge clamps together, causing them to grip the elevator guides and stop the car.

Automatic retarding of speed and the final positive stopping at the top and bottom of the shaft are accomplished by 2 groups of switches, one at the top and one

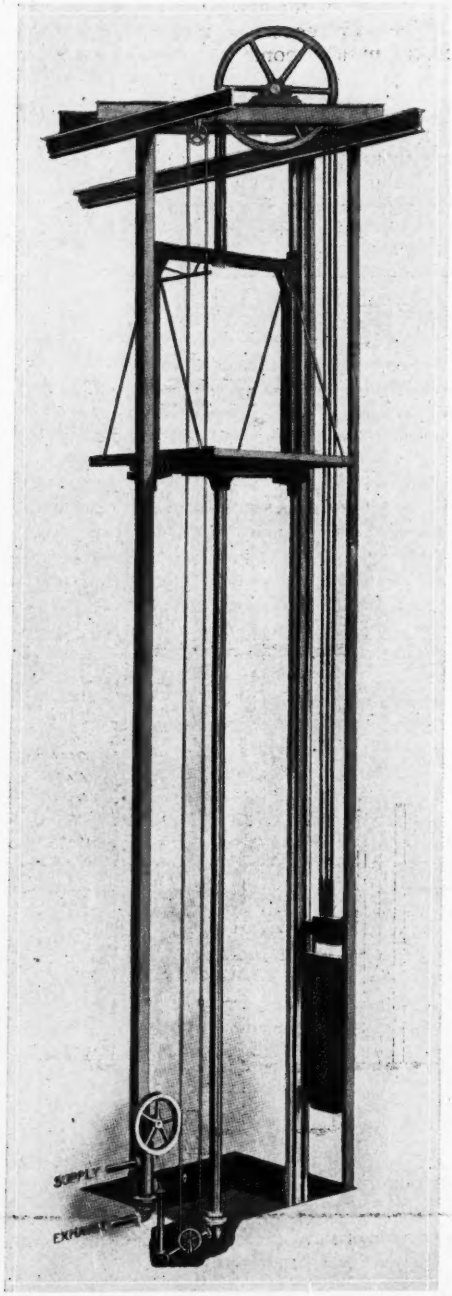


FIG. 12. OTIS PLUNGER ELEVATOR FOR FREIGHT SERVICE

at the bottom, each switch in the series being opened, one after another as the car passes, resulting in reduction of speed, the final switch bringing the car to a stop by applying the brake.

Impact at the bottom is provided for by 2 oil cushioned bumpers, one under the car and one under the counterweight. The bumpers are arranged to

bring either the counterweight or the car to a positive stop with carefully regulated speed as oil is forced from one chamber of the buffer to another.

The signal system with which these cars are provided is known as the hotel flash light annunciator, and has indicating dials placed on the ground floor, to show the location of the cars in the hatchway.

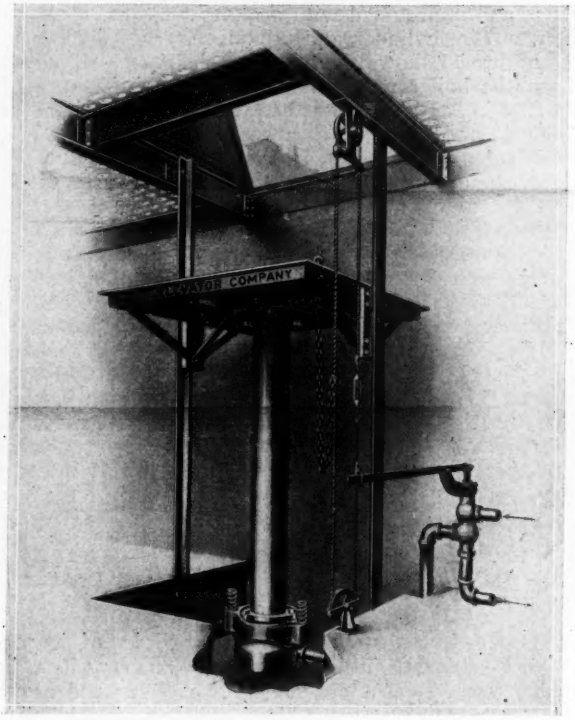


FIG. 13. OTIS HYDRAULIC SIDE WALK HOIST

One of these cars serves from the basement to the 11th floor and the other from the first floor to the 11th floor, a 133-ft. rise for the former and 121 ft. rise for the latter.

Both the service elevator and the freight elevator are of the electric single worm-gear drum type with the machines located in the basement, the former being driven by a 7½-hp. and the latter by a 12-hp., 220-volt direct-current motor. The service elevator is designed to lift a maximum load of 1500 lb. and to travel at a speed of 200 ft. a minute, with a load of 1200 lb., and is operated by means of a switch located in the car. The freight elevator is designed to lift a maximum load of 2500 lb. and to travel at a speed of 150 ft. a minute with a load of 2000 lb., and is provided with hand rope control. Both elevators are provided with the standard up and down needle type annunciator. The service elevator car is 4 ft. wide by 5 ft. 3 in. deep and the freight elevator car 5 ft. 5 in. wide by 7 ft. 1 in. deep. Both these elevators are arranged to serve from the basement to the pent house floor and have a rise of 149 ft. 6 in.

Hydraulic Elevators

HYDRAULIC elevators are all of the plunger type with the hydraulic cylinder set vertically in the ground directly under the car. In the cylinder is a plunger of the same length carrying the car at its upper end and supported by an incompressible body of water, and the car cannot descend faster than the water is let out of the cylinder. To make room for the hydraulic cylinders, holes were sunk into the ground a distance equal to the height of the elevators' travel.

Several lengths of pipe make up the cylinders which are turned true on the ends and joined by sleeve couplings. The upper end of the cylinder is screwed into an iron casting bored to fit the plunger and provided with a stuffing box and pipe connections for the inlet and outlet water; the lower end of the cylinder is closed by a cap.

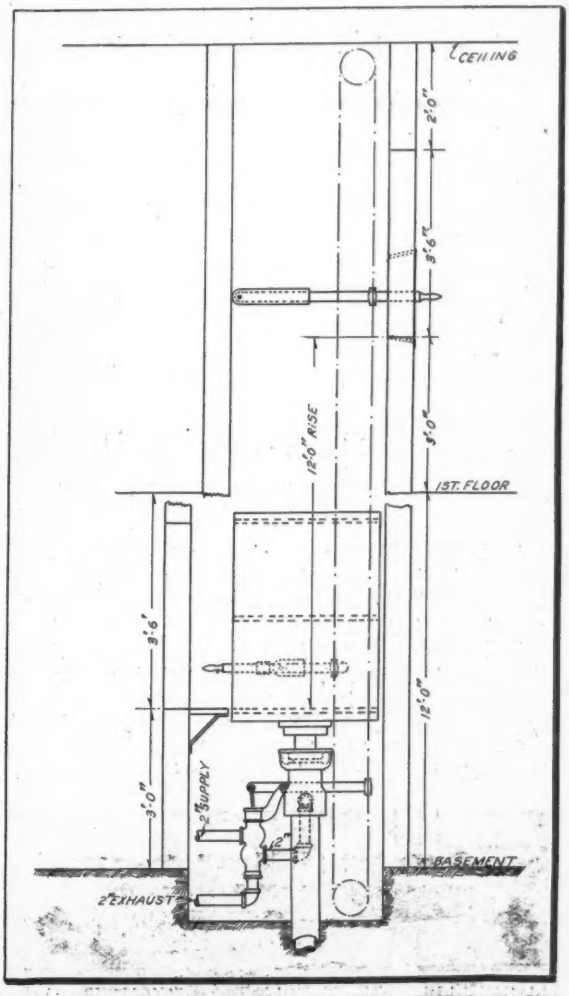


FIG. 14. SECTIONAL ELEVATION OF HYDRAULIC BAR LIFT

The plungers consist of a number of lengths of steel pipe, turned and polished, the sections being joined by means of long internal sleeves so proportioned that the transverse strength of the plunger at the joint is equal to the continuous section. The stuffing box at the upper end of the cylinder and guide shoes at the lower end of the plunger serve to keep the plunger in line and central. From the top of the car a number of cables pass over sheaves at the top of the shaft and connect to the counterweight to reduce the pressure required to raise the car and to relieve the compression stress on the plunger.

When the car is at the bottom of the shaft, the plunger is immersed in water in the cylinder and a portion of the weight is thereby balanced. When the

car is at the top of the shaft, the weight of the car and of the plunger, which is about 22 lb. per foot, is not counterbalanced to any extent and were it not for the cables the total weight lifted would be less at the bottom than at the top. The weight of the cables, however, is so proportioned that the total weight is about equal at all points as when the car is at the bottom of the shaft, the cables hang above it and offset a portion of the counterbalance weight, but when the car is at the top of the shaft, the cables are above the counterbalance weight and add their weight to it.

All of the hydraulic elevators are designed to operate from pressure obtained from the city water mains which is about 90 lb. per square inch and discharge the waste water into the sewer.

The ball room elevator is designed for service between the first and second floors only, has a rise of 18 ft. 6 in., and will carry a maximum load of 2000 lb. and travel at a speed of 150 ft. a minute with a load of 1000 lb. It is operated by a hand rope which actuates a 4-in. rack valve; the plunger is 7½ in. in diameter and the cylinder 9 in. in diameter while the car is 7 ft. 2 in. wide and 6 ft. 1 in. deep.

The trunk lift serves from the basement to the platform at the sidewalk level and is designed to lift a maximum load of 2000 lb. and to travel at a speed of 40 ft. a minute with a load of 1000 lb. The platform is 6 ft. wide by 7 ft. 7 in. deep, and the valve is operated by means of a lever located at the basement floor level. This elevator has a plunger 7½ in. in diameter, a 9-in. cylinder and a 2-in. lever-arm valve.

Running from the sub-basement to the basement is the freight elevator, illustrated in Fig. 12, which is designed to lift a maximum load of 1000 lb. and to travel at a speed of 40 ft. per minute, with a load of 500 lb. It has a platform 4 ft. 10 in. wide by 3 ft. 4 in. deep, and is provided with a plunger 5½ in. in diameter, a 7-in. cylinder and 2-in. lever-arm valve.

Figure 13 shows the plunger ash lift, which serves from the boiler room to the sidewalk, a distance of 24 ft. 6 in., and is designed to lift a maximum load of 1500 lb. and to travel at a speed of 40 ft. a minute, with a load of 750 lb. It has a platform 5 ft. 5 in. square and is provided with a 2-in. lever-arm valve, a 6½-in. plunger and an 8-in. cylinder.

In addition to these elevators a lift has been provided to serve from the basement to the barroom on the first floor, which is shown in section in Fig. 14. It is designed to raise a load of 500 lb. and to travel at a speed of 40 ft. per minute with a load of 350 lb. The operation of the lift is controlled by means of 2 levers, one at the first floor and one at the basement. These levers operate the cable which in turn actuates the valve. The lift is provided with a 4½-in. plunger, a 6-in. cylinder and a 2-in. lever-arm valve and the size of the car is 2 ft. 5 in. by 2 ft. 10 in.

BLONCK BOILER EFFICIENCY METER

Convenient Combination of Gages Gives Fireman Definite Information of Furnace and Load Conditions

UNCERTAINTY as to the exact condition of the fire in the furnace has made firing a boiler an art which can be attained only through practice under the guidance of one who is a master of the art.

An instrument which indicates instantaneous changes not only in the furnace but in steaming capacity, has long been sought as a guide for firemen and is at last available; it is known as the Blonck Boiler Efficiency Meter.

As will be noted by the illustration, the Blonck meter is a combination of 2 sensitive draft gages, one connected between the atmosphere and the furnace and one connected between the furnace and breeching on the boiler side of the damper. The lower one, filled with red oil, gives a relative indication of the pressure with which the air rushes into the furnace or the resistance of the fuel bed, while the upper gage, filled with blue oil, gives a relative measure of the amount of combustion gases passing the boiler proper.

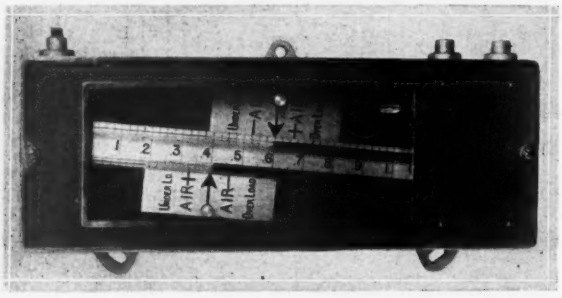


FIG. 1. BLONCK BOILER EFFICIENCY METER

In addition to the 2 gages the meter is provided with 2 sliding scales (see Fig. 1) which are to be adjusted to the best and most efficient operating condition of the particular boiler; the instrument should be mounted on the boiler front, so that firemen, chief engineer and owner can see at a glance the working conditions of each boiler.

It is known that a draft gage indicates a difference in static pressure. As gases in the chimney are lighter in weight, volume for volume, than the air outside the chimney, there is a tendency for the gases to rise, being pushed up by the air beneath. If there were no resistance to the air through the ash pit door, grate and fuel bed, the pressure in the furnace would be the same as the atmosphere, so far as we are capable of measuring it.

As a matter of fact, however, these do offer a resistance and the greater their resistance the greater will be the difference in pressure between the furnace and atmosphere and the higher will be the gage reading; in other words, the thicker the fuel bed or the more the grate is clogged with clinkers the higher will be the draft gage reading; or if the resistance is reduced by holes developing in the fuel more air will pass into the furnace and the draft gage will read lower.

Suppose that the draft gage gives a low reading, it would naturally be expected that a great amount of air is passing through the furnace, this excess of air may produce complete combustion, but at the same time reduce the temperature and since there is more oxygen in the air than can be taken up by the carbon in the fuel the percentage of CO_2 in the gases will be low. Going to the other extreme, if the furnace gage reads high this indicates that the resistance through the fuel bed is great and little air is passing. The result is a lack of air supply and sufficient oxygen does not reach the coal to cause complete combustion, and an analysis of the flue gases shows carbon monoxide. Between these 2 extremes is the point where just enough air passes through

the fuel to cause complete combustion without reducing the temperature of the gases; so, for normal operation, this medium gage reading should be carried.

Should a load greater than normal come upon the boiler, it would be necessary to carry a little thicker

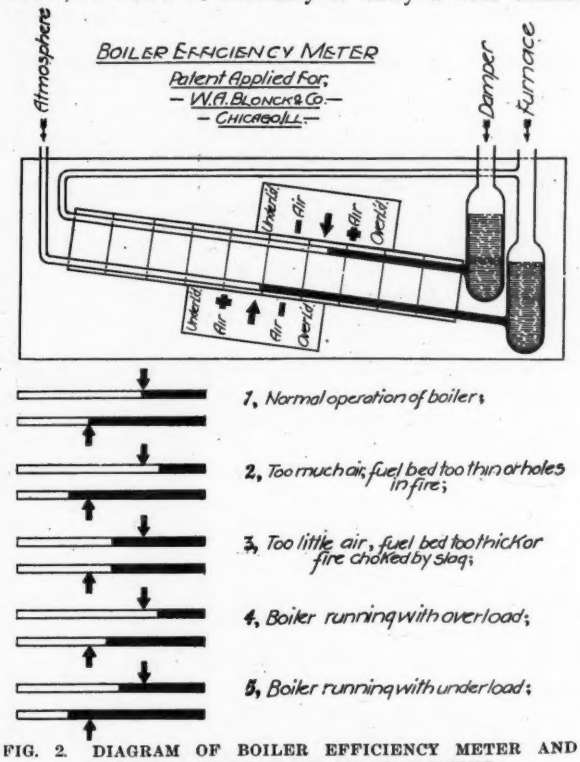


FIG. 2. DIAGRAM OF BOILER EFFICIENCY METER AND PRINCIPAL INDICATIONS OF INSTRUMENT

fire and at the same time a little more air in order to secure complete combustion, therefore the gage would read a little higher than normal. An underload would have the opposite effect.

From the above it will be seen that any slight change in the fuel bed will be indicated by a change in the reading of the furnace draft gage.

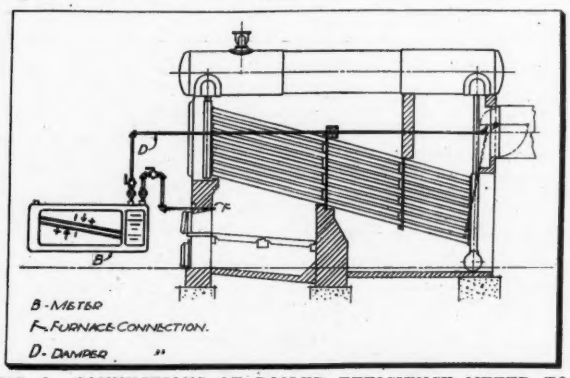


FIG. 3. CONNECTIONS OF BOILER EFFICIENCY METER TO WATER TUBE BOILER

Taking up a similar discussion of the differential draft gage, i. e., the gage showing the difference in pressure between the furnace and the damper, we find that changes in the amount of air furnished the fuel affect it oppositely to that of the furnace draft. For instance, too much air causes greater resistance through the tubes and a higher differential gage reading, too little air passing offers little resistance and a low gage reading, for normal operation there is, therefore, as in the other case, a medium gage reading which should be maintained.

Taking abnormal conditions, an overload on the boiler requires more gases to go through the tubes with consequent higher resistance and higher differential gage readings. An underload will have the reverse effect on the gage.

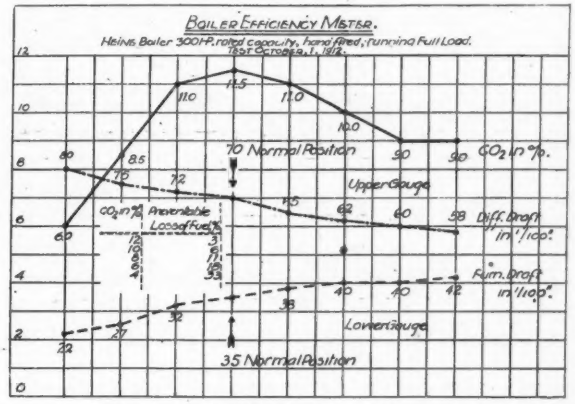


FIG. 4. TYPICAL READINGS FOR A WATER TUBE BOILER

By placing the gages together, as is done in the Blonck meter, the relation between the readings can easily be observed and a slight change in the operating conditions of the boiler can instantly be noted and normal conditions restored before serious waste can take place. The 5 positions shown in Fig. 2 are those most commonly noted though others such as dirty flues or a fallen baffle, are just as readily and instantly shown by the meter.

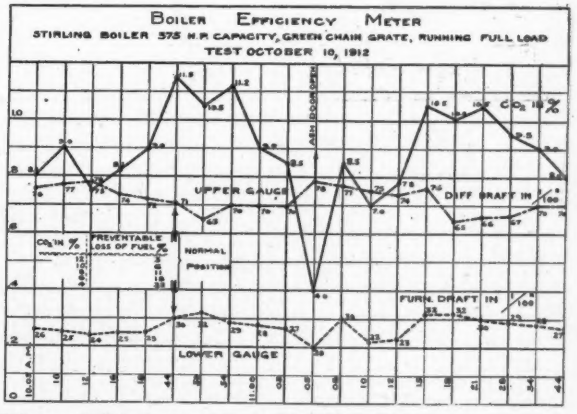

Boiler Efficiency Meter
Stirling Boiler 575 H.P. Capacity, Green Chain Grate, Running Full Load
Test October 10, 1912
Upper Gauge
Diff. Draft in 1/100
Normal Position
Lower Gauge
Furn. Draft in 1/100

FIG. 5. RESULTS OF TEST ON BOILER WITH CHAIN GRATE SHOWING EFFECT OF OPEN ASH DOOR

When installed on boilers in batteries, the meter is of further value in keeping the boilers evenly loaded.

The connections between the instrument, furnace and boiler side of damper consist of standard 1/8-in. steel piping, as shown, for instance, on a hand fired B. & W. boiler in Fig. 3.

The procedure for adjusting the instrument to the most efficient operation of the boiler should take place while the boiler runs with a steaming capacity equivalent to the longest period of average load, then the following 3 conditions taking place simultaneously will give the best economical results:

A. White fire with fully covered grate giving high CO_2 in flue gases;

B. Low draft over the fire, or low red gage;

C. Large pressure drop between fire and damper showing maximum amount of combustion gases, or high blue gage.

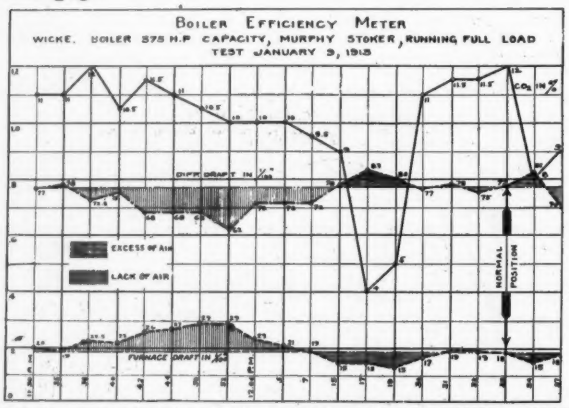

BOILER EFFICIENCY METER
WICKE. BOILER 575 H.P. CAPACITY, MURPHY STOKER, RUNNING FULL LOAD
TEST JANUARY 9, 1913
CO2 IN %
DIFF. DRAFT IN 1/10"
EXCESS OF AIR
LACK OF AIR
NORMAL POSITION
FURNACE DRAFT IN 1/10"

FIG. 6. TEST SHOWING RELATION BETWEEN AIR SUPPLY AND CO_2 IN FLUE GAS

Figure 4 represents, for instance, the hand-fired operation of a Heine Boiler, which was running at its best efficiency, when allowing 0.35 in. of draft over the fire and about 0.70 in. friction loss between fire and damper.

CO_2 in per cent	Air Excess in per cent	Fuel Loss in per cent	Preventable Fuel Loss in per cent
12	72.5	15	3
10	107	18	6
8	158.7	23	11
6	245	30	18
4	417	45	33

Applying the above table, it will be seen that the normal setting of the instrument will insure the least preventable fuel loss. It will be further noticed that indications to the left of the arrows represent excess air conditions, while the indications to the right of the arrows represent lack of air.

In practical operation the instrument shows the fireman distinctly when to put on fresh coal, cover up holes or clean the fire. While making this test, for instance, a firing period lasted about 3 min.; with a fresh fire the meter would stand at 35 and 70 (at the arrows' points)

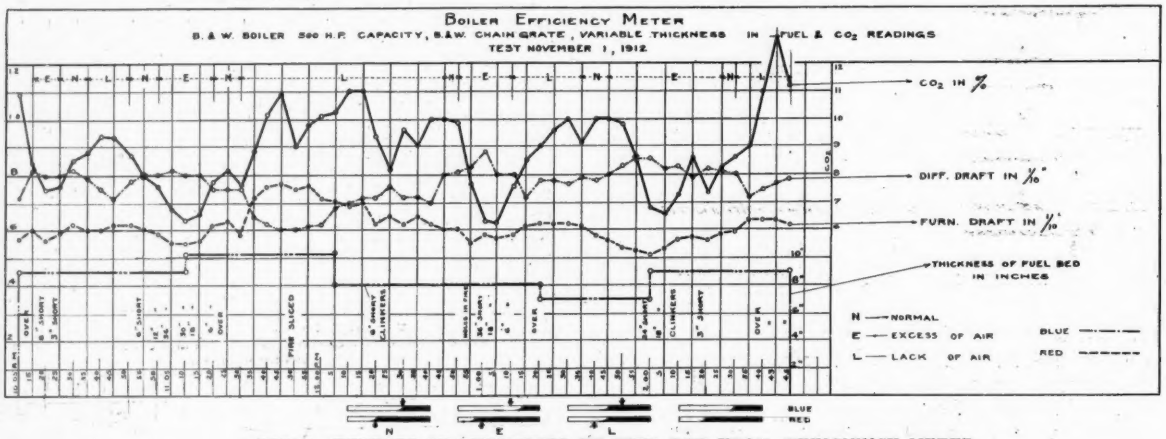

BOILER EFFICIENCY METER
B. & W. BOILER 500 H.P. CAPACITY, B.&W. CHAIN GRATE, VARIABLE THICKNESS IN FUEL & CO2 READINGS
TEST NOVEMBER 1, 1912
CO2 IN %
DIFF. DRAFT IN 1/10"
FURN. DRAFT IN 1/10"
THICKNESS OF FUEL BED IN INCHES
N NORMAL
E EXCESS OF AIR
L LACK OF AIR
BLUE
RED

FIG. 7. EFFECTS OF THICKNESS OF FUEL BED UPON EFFICIENCY METER

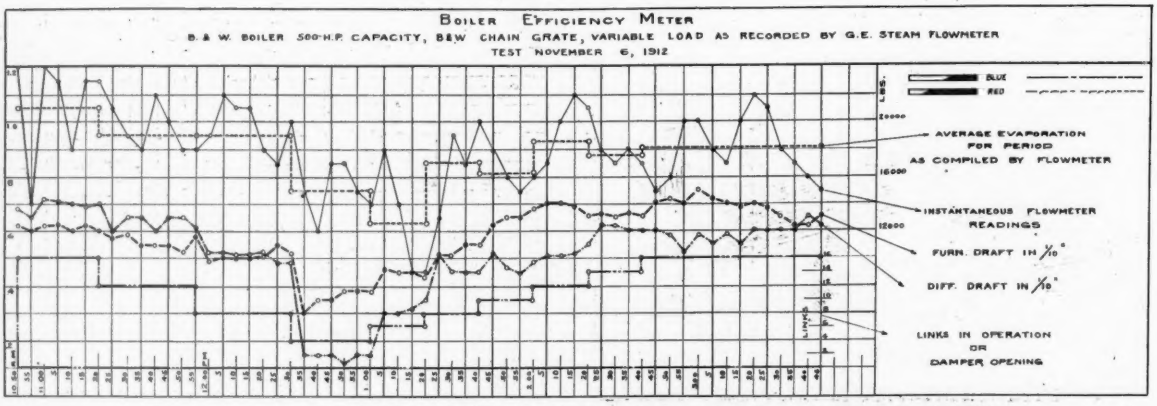

BOILER EFFICIENCY METER
B. & W. BOILER 500 H.P. CAPACITY, B&W CHAIN GRATE, VARIABLE LOAD AS RECORDED BY G.E. STEAM FLOWMETER
TEST NOVEMBER 6, 1912
BLUE
RED
AVERAGE EVAPORATION FOR PERIOD AS COMPILED BY FLOWMETER
INSTANTANEOUS FLOWMETER READINGS
FURN. DRAFT IN 1/10"
DIFF. DRAFT IN 1/10"
LINKS IN OPERATION OR DAMPER OPENING

FIG. 8. EFFECTS OF LOAD VARIATIONS UPON BOILER EFFICIENCY METER READINGS

In order to prove the adjustment a large number of tests were made, some of which are given here in diagram form; these performance curves are obtained by taking simultaneous observations of the Blonck Boiler Efficiency Meter and flue gas samples; the latter were analyzed for their content of CO_2 by means of an Orsat or Hayes machine.

and would then move gradually to the 25 and 78, indicating an excess of air, and fresh fuel would bring the meter back to the arrow points; these indications are repeated like clockwork. As the fire gets dirtier and the cleaning period approaches, the meter will gradually move its position to 40 and 62, calling the fireman's attention to the lack of air condition in the furnace.

Figure 5 shows the performance curve of a Stirling boiler with a Green chain grate stoker; the abrupt drop of CO_2 at 11:05 and the corresponding expansion of the distance between the 2 gages could not be accounted for on the operating floor, but later it was found that the ash tender in the lower basement had opened the ash cleaning doors.

The above curve is complete evidence that valuable information is given by the instrument by observing the location of both gages in relation to each other, while each gage by itself does not give the desired result.

Figure 6 shows the performance curve of a Wickes water-tube boiler with a Murphy stoker, and lack and excess of air are discriminated in the shading in order to show their occurrence during the test.

Another fact can be gleaned by observing this curve somewhat closely; namely, that CO_2 is a criterion only for furnace efficiency during the period of excess air, while during the period of lack of air the CO_2 is practically constant and yet no doubt the steaming capacity of the boiler is greatly reduced.

Figure 7 gives a more elaborate test on a B. & W. boiler with B. & W. chain grates, running with various thicknesses of fire and testing the indication of short and long fire on the boiler efficiency meter. Beginning with a 9-in. fire, a small distance between the 2 gage indications means again a high percentage of CO_2, while with a growing distance of the gage indications a lowering of CO_2 or wasteful conditions appear.

At 11:10 the grate of the stoker was raised for a 10¼-in. fire; this manipulation becomes effective about 40 min. later, allowing for the slow travel of the grate. Then it will be noticed that the draft over the fire surpasses the differential draft between furnace and damper, or, in other words, the resistance of the fuel bed becomes larger than the friction of the gases passing the boiler, meaning that a smaller quantity of combustion gases pass the boiler, consequently a lower rate of steaming of the boiler in spite of the high CO_2 value.

Figure 8 shows a test with the same B. & W. boiler by comparing the indications of the General Electric Steam Flow Meter with those of the Boiler Efficiency Meter; various degrees of steaming capacity were obtained by closing and opening the damper a certain number of links as indicated in the diagram. It will be seen that instantaneous indications of the steam flow meter are entirely dependent on the rate of feeding the boiler, left to the discretion of the water tender. Allowing, however, for the time element due to the rate of feeding, it will be seen that the curves of average evaporation and relative indication of the Boiler Efficiency Meter are nearly parallel, so that the relative distances of both gages from the arrow setting give a relative measure of the load carried by the boiler.

Increase or decrease of both gages should, however, be in proportion to the arrow setting, otherwise an uneconomical condition will prevail, which will result in reduced steaming capacity. This fact is clearly shown in the above curve; for instance, at 12:20 the furnace draft passes the differential draft and that condition prevails nearly to the end of the test; it will, however, be noticed that with the same damper opening at the beginning and the end of the test the latter gives only an average of 18,500 lb. per hour steaming capacity instead of 21,000 lb.; this no doubt is due to the smaller amount of combustion gases passing the boiler on account of the reversed draft distribution.

Figure 9 shows the performance curve on an Edge Moor boiler with a Dutch oven furnace burning shavings using a thin bed of coal on a stationary grate for ignition purposes. It will be seen that changes in the draft distribution are violent due to the uneven discharges of wooden shavings through the chute from the cyclone collector.

These tests show quite conclusively that the Blonck meter indicates furnace conditions as well as the load variations. While it does not give absolute values of

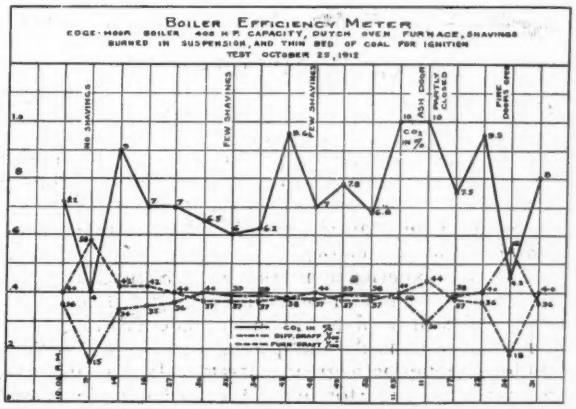

BOILER EFFICIENCY METER
EDGE-MOOR BOILER 400 H.P. CAPACITY, DUTCH OVEN FURNACE, SHAVINGS BURNED IN SUSPENSION, AND THIN BED OF COAL FOR IGNITION
TEST OCTOBER 25, 1912
NO SHAVINGS
FEW SHAVINGS
FEW SHAVINGS
ASH DOOR IS PARTLY CLOSED
PUT DAMPER ONE
CO2 IN %
DIFF. DRAFT
FURN. DRAFT

FIG. 9. TEST OF A FURNACE BURNING SHAVINGS WITH BOILER EFFICIENCY METER

CO_2 or rate of steaming, the readings do give the relation to normal operations and, being instantaneous, the readings are a definite guide to the fireman telling him what has taken place in his furnace, when to fire, when the grate is clogged with clinkers, when holes have developed in the fire, and many other detrimental conditions which can be remedied if known to exist.

U. S. Civil Service Commission announces an open competitive examination for petroleum engineer, for men only. From the register of eligibles resulting from this examination certification will be made to fill a vacancy in this position at a salary ranging from $2000 to $3600 a year in the Bureau of Mines, Department of the Interior, for services in the field, and vacancies as they may occur in positions requiring similar qualifications, unless it is found to be in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

Applicants must have reached their 24th but not their 40th birthday on the date of the examination.

Statements as to educational training, experience, and fitness are accepted subject to verification.

This examination is open to all men who are citizens of or owe allegiance to the United States and who meet the requirements.

Persons who meet the requirements and desire this examination should at once apply for application Form 304 and special form to the United States Civil Service Commission, Washington, D. C.; the secretary of the board of examiners, post office, Boston, Mass., Philadelphia Pa., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Cal.; customhouse, New York, N. Y., New Orleans, La., Honolulu, Hawaii; old customhouse, St. Louis, Mo.; or to the chairman of the Porto Rican Civil Service Commission, San Juan, P. R. No application will be accepted unless properly executed and filed with the Commission at Washington in complete form, with the material required, prior to the hour of closing business on February 24, 1913. In applying for this examination the exact title, United States Civil-Service Examination, Petroleum Engineer, should be used.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

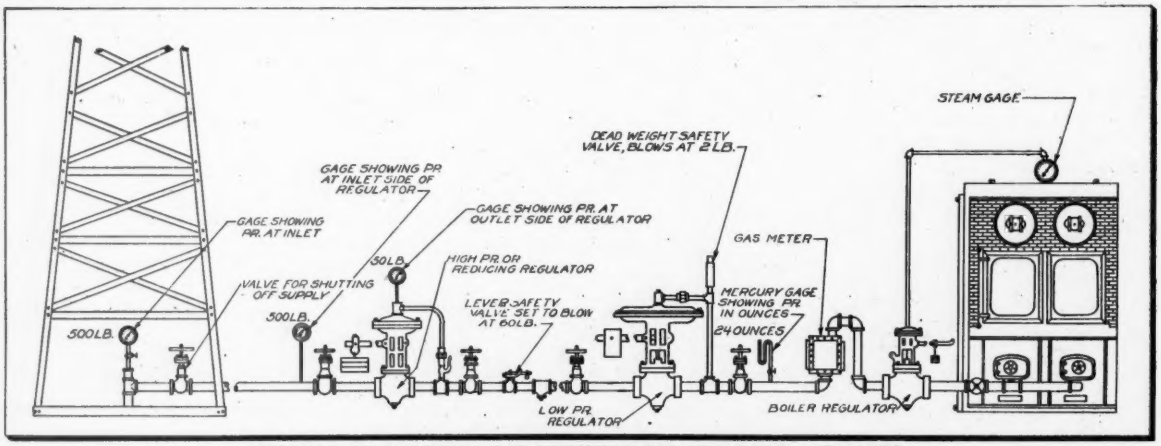
FIRING WITH NATURAL GAS

IN the December 1 issue I notice that H. L. S. gives some timely hints in regard to firing boilers with natural gas. But I wish to take exception to his statement in regard to the color of flame, kind of burners and regulation of air. It is my daily duty to visit factories using natural gas as fuel for boilers, stills, furnaces and gas engines.

In my experience in the gas business and firing boilers for a number of years with gas, I have never seen or heard of plants being run successfully where a white flame is used. Comparing a gas jet to the burner under a boiler is a great mistake. In the first place, a gas jet is made for light; the burner under a boiler is made for heat. The old-fashioned gas jet is fast disappearing, being replaced by the mantle in which you mix air with the gas through a mixer at the bottom of the burner, thereby increasing the heat to incandescence, the mantle giving a bright light.

If you take a piece of paper and by pulling it over flame quickly, thereby smother it, you notice that there is a black ring on the paper which plainly shows that the flame was not solid. It is not necessary to use compressed air to obtain a blue flame; the gas will take air with it if given the chance. As for bagging a boiler, that is done with any fuel if conditions are such as to cause it to happen.

Boilers used for drilling oil and gas wells use gas when it is convenient. They use the line pressure which is generally from 100 to 200 lb. In a burner known as the fan burner, the flame is blue; a piece of copper wire melts in the flame as if it were tallow; the roar of the burner is terrific. These boilers consume about 100,000 cu. ft. per day of 24 hr. and I have never seen an oil well boiler bagged. Gas without air will not burn; it takes from 12 to 14 cu. ft. of air to 1 cu. ft. of gas to get right combustion.


STEAM GAGE
DEAD WEIGHT SAFETY VALVE, BLOWS AT 2 LB.
GAGE SHOWING PR AT INLET SIDE OF REGULATOR
GAGE SHOWING PR. AT OUTLET SIDE OF REGULATOR
GAGE SHOWING PR. AT INLET
GAS METER
50 LB.
HIGH PR. OR REDUCING REGULATOR
VALVE FOR SHUTTING OFF SUPPLY
MERCURY GAGE SHOWING PR. IN OUNCES
LEVER SAFETY VALVE SET TO BLOW AT 60 LB.
500 LB.
500 LB.
24 OUNCES
LOW PR. REGULATOR
BOILER REGULATOR

METHOD OF REDUCING GAS PRESSURE FOR USE UNDER BOILERS

If the reader wishes to try an experiment and is using natural gas for lights, if he will shut the air off his light he will notice that the flame burns high above the globe. Now if he will hold a piece of bright tin above it he will notice that it becomes blackened; this deposit is known as lampblack or carbon.

To get a white flame under a boiler the air must be excluded; what would happen to the flues of your boiler is not necessary to mention. It is a common expression in the gas belt, when one sees smoke coming from the stack where gas is used as fuel, to say he has got his air cut out. The old-fashioned gas jet was a great smoker; in a month's time it was easy to write your name on any ceiling where the jet was used. One of the main features of the mantle is to eliminate that as far as possible.

The bunsen burner gives as perfect combustion as is possible to get; the flame is blue-purple, cone shaped, becoming somewhat light at the tip of flame.

The sketch shows the way gas is piped from well to consumer, also showing the regulator used to shut off when steam is high, making it unnecessary for a fireman to touch a gas valve while on duty. It is generally figured that it takes 40 cu. ft. per hp.-hr. for boilers and from 10 to 14 cu. ft. per hp.-hr. for gas engines.

For boilers we furnish gas at 24 oz. pressure; for gas engines at 8 oz. The gas is sold on the basis of 4 oz. pressure.

I claim that gas is the ideal fuel for boilers and if it can be obtained at a reasonable price, is the best to use where good results are the aim. L. E. Conroy.

I have read with great interest the criticism on our method of burning natural gas, and I must say that it "reads well."

The reason that a mantle makes a shorter flame on a gas jet is because it heats the gas and causes a more

perfect combustion consuming the carbon. This is substantially what happens to the flame as it passes through the checker work of brick under a tubular boiler. Too much air going into the gas makes a short blue flame, causing too much air to be heated. This can be carried to excess to the point of blowing out the gas. All gas companies do not base their sales on a 4-ounce pressure, as the company that employs me purchase on an 8-ounce basis, that is, for higher pressure a multiplier is used. Several companies manufacturing gas meters furnish these tables in their catalog. The Equitable Meter Co. of Erie, Pa., has this information as well as a great many other facts and formulae concerning natural gas. I wish to say that the boilers in which we used natural gas here did not get the flues filled up with soot, nor did our burners smoke. In one case we substituted a new patent burner for those in use, expecting to get a great deal better results, but as we were already getting about 80 per cent efficiency we could not do any better although the manufacturer of the burners claimed to be doing the work with one-half less gas in many places. Forty cubic feet per hour per horsepower seems to me to be nearly right. Although, of course, the grade of the gas has something to do with that. A boiler horsepower is 34.5 lb. of water per hour from and at 212 deg. F. To do this requires 966 B.t.u. per pound of water, or $966 \times 34.5 = 33270$ B.t.u. 40 ft. of gas would have 40,000 B.t.u. at 1000 B.t.u. per cu. ft. or $33{,}270 \div 40{,}000 = 83$ per cent efficiency, very nearly.

Most drilling well boilers take gas without a meter and few of them have any idea how much gas they do burn.

Not only that but drilling outfits have boilers and engines of so many different sizes that it is hard to say just what they should burn unless you know about the particular one. A deep well needs a more powerful engine and a larger boiler than a shallow well, to do its drilling. Some fields (oil or gas), start with larger holes, on account of veins of water to be cased off, as one string of casing has to be put inside of another. A large hole and a deep well, means heavy tools, heavy drilling cable and heavy machinery. If we suppose the boiler to be 25 hp. 100,000 ft. per day of 24 hr. means about 4200 per hr.

The 25-hp. boiler should evaporate 862.5 lb. of water per hour. Heat units should be 833,175, while the B.t.u. in 4200 cu. ft. of natural gas should be 4,200,000 or $833{,}175 \times 100 \div 4{,}200{,}000 = 19.8$ per cent efficiency, very nearly. Not very high is it?

Then all gas companies do not furnish gas for domestic consumption at a pressure of 4 ounces. I know of one gas company in Illinois that purchased the gas from a gas well owner at well pressure and supplied a village of 3000 inhabitants with it while the well owner did not get enough out of it to pay the gas bill for his residence.

At one time one of my duties was looking after the pressure reducing valves that supplied a city of 40,000 inhabitants. Of course near the regulators the pressure was higher but on the outer ends of lines, especially if they were not circuited, the pressure dropped down. We used to carry a 6-ounce pressure but would increase it according to the needs, and the carrying capacity of the lines, consumption, etc. A recent inquiry of a company supplying 30 or 40 towns, gave me the information that they carried from 8 to 12 ounces. There are so many different things that enter into this matter that I do not think ironclad rules are usually in force. H. L. Sherman.

OIL AS FUEL

I READ with much interest the letters of Anon, page 1246, and John Pierce, page 1223, Dec. 15 issue of Practical Engineer. But it is the latter of these letters to which I wish to reply. We tried burning oil for a period of several weeks, and did everything that we thought of and could afford to do. The boilers were Cahall water-tube type, 18 ft. long, 2 vertical baffleplates ½ in. draft burners were placed in front of furnace over 54.53 sq. ft. grate area which we covered with fire brick and adjusted in different ways, also built up wall in the furnace in our frantic effort to get results and did everything spoken of by both Mr. Pierce and Anon in the articles cited above. I did practically nothing for 7 weeks but study the combustion of oil in our furnace.

One day, when I was returning to the boiler room from the engine room, I saw our second fireman standing at the side of the boiler folding a strip of paper. I watched him to see what he was up to and finally he walked over to one of the holes for blowing flues and lifted up the plate and inserted his strip of folded paper. He wanted to get a light for a cigarette, but the heat between the second topped plate and the breeching was not even enough to char the paper and by further investigation we found that the temperature in this portion of the setting was not appreciably above that of the boiler contents. This we contended left half of the heating surface to do all the work, while the other half did nothing. Steam pressure, however, was steady, but we were using 150 to 175 gal. of oil a day, more than the price of coal would justify. I may mention here that once we got our furnace warmed up no smoke would be seen issuing from our stack.

Our experience and observations led us to the conclusion that the possibilities of oil as an economical fuel for steam boilers under conditions prevailing at our plant, are not sound enough to justify us in making the many costly changes and installations that are required.

We believe that to make oil burning under steam boilers a success it will be absolutely necessary, first, to gasify and expand the oil before it reaches the boiler furnace so that it will not expand appreciably after it reaches the furnace. The velocity of flow through the burners must be due to the expansive effort of the fuel and not due to air, steam or head pressure due to gravity.

The draft must not be more than will just create a moderate circulation.

The expansion of the gases in the furnace is the main thing to prevent. Thos C. Robinson.

SLOTTING THE COMMUTATOR

AN article on Slotting the Commutator in Jan. 15 issue, interested me and I could not resist the temptation to give my views on the matter. I give the writer of the article, L. M. Johnson, credit for his genius in rigging up his device but I prophesy that he will have his troubles with these slots before long.

I contend that this slotting is unnecessary, and the whole trouble comes from using the block he speaks of with sandpaper on it. When using the block, if too much pressure is put on and the sandpaper used too long it will push the copper off and leave the mica high, which causes the whole trouble. If the commutator is turned off with the right kind of a tool which cuts copper and mica even all the way across there will be no trouble with sparking.

About 8 yr. ago I took charge of one of the street railway power houses in a city where they had been in

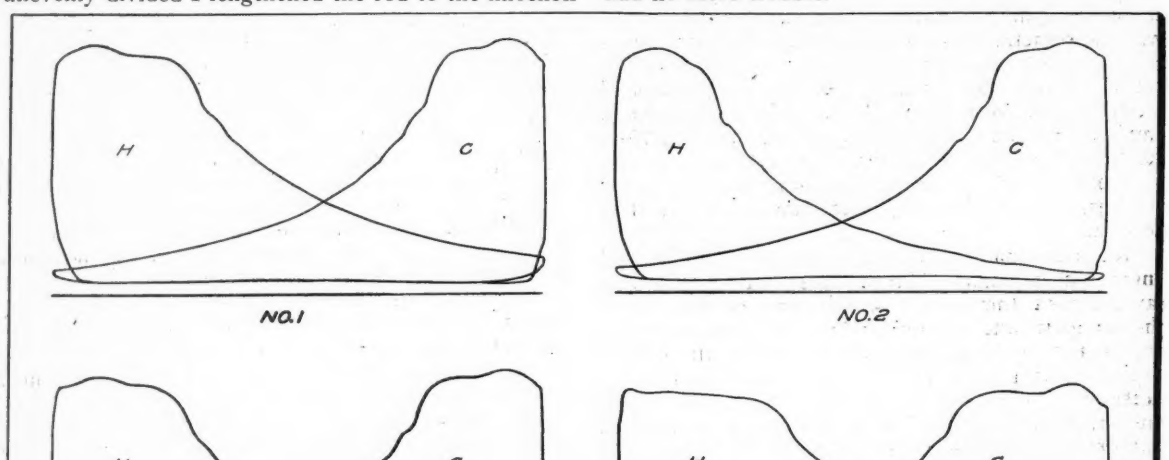
the habit of slotting the commutators with a hack saw blade. These slots would fill up with carbon dust and short circuit the segments and at times there would be a circle of fire all the way around the commutator. It was getting to be a serious problem.

He says his slots keep clean but as I said before he will have his troubles before long; a little oil is bound to get into these slots to which the carbon dust will adhere and then the trouble commences.

In the case of which I speak, I turned off all these commutators with the proper kind of a tool and was sure that the mica was cut even with the copper all the way across and we had no more trouble, and after this I allowed no more slotting and very careful sandpapering. Joseph H. Unsworth.

INDICATOR DIAGRAMS FOR DISCUSSION

ENCLOSED find indicator cards which I would like to have explained through columns of Practical Engineer. Numbers 1 and 2 were taken without making any adjustments to valves. Thinking the load too unevenly divided I lengthened the rod to the knockoff cam on crank end, which I think gives better results as shown in Nos. 3 and 4. What is the cause of the uneven steam line most noticeable in crank end diagram? E. A. F.



CARDS WITH UNEVEN STEAM LINE

TROUBLE WITH EXPANSION JOINT AND DUPLEX PUMP

I TOOK charge of the steam end of a plant 9 yr. ago where they had all kinds of trouble with the power; the engine had been run by all hands from the foreman down. One morning the foreman went downstairs to start up as the regular fireman had gone to town. He told the new man to turn on the steam from the boilers. They were 100 ft. from the engine and there was an expansion joint midway in the steam line.

The new man climbed on top of the boilers and instead of turning on steam gradually, he threw the valve wide open. The foreman had just stooped down to see if the bleeders were open, when the throttle valve broke. One piece grazed his head enough to cut a bad gash and the other went the length of the engine room and through the siding.

A new valve was put on and stood up just one week and cracked the entire height where the old one had let go. In taking charge I thought I would have a look at this expansion joint, which was under ground in a trough. I found the pipe had settled badly and the joint was so jammed it could not slip. We leveled up the pipe and put some small pipe rollers under it, packed the joint over and had no more trouble with that part of it.

I next found the duplex pump out of commission. After setting the valves on the steam end and truing up the water valves, the pump went along nicely. I found, when I had set the steam valves and plumbed the rockers, there were just 4 threads left on each end of the stems; I set this down on a post beside the pump for future use. I held this job for 5 yr. and had no more trouble.

Recently the foreman had trouble with the pump while I was visiting in the neighborhood and we first went through the water end and found the packing good and the water valves seating nicely, none of them sticking on the stems.

We next took off the steam chest cover and the valves had been moved from where I had them when I ran the plant. We turned the stems until there were just 4 threads left on each, then tried the pumps: nothing occurred except a little double shuffle. We then took off the cylinder heads and there was the trouble as big as you please, a small piece of the gasket had blown out between the 2 cylinders under the heads and they were working against each other. We put in a new gasket and the pump started off nicely. The engineer then asked me why I thought just 4 threads were right. I told him about running this pump for 5 yr. and showed him my old marks on the post. Chas. Burns.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repairs of Broken Piston Head Flanges

BREAKAGE of portions of the flanges of solid piston heads is by no means an uncommon occurrence. Accidents of this kind are due more to the presence of foreign matter in the clearance spaces at each end of the cylinder, than to any weakness of the metal of the head or undue strains placed on it by changing of the engine load. Snapping of cylinder packing rings of an inferior grade is another cause of breakages of this portion of the piston head.

In a great many instances after the breakage of a portion of the piston head flange, the head is promptly discarded as useless and another ordered from the factory or made at the nearest machine shop, which is often a considerable distance from the plant. Such procedure necessitates in many cases the sending of a sketch or the broken head itself for direction or model. The repair of such breakage is, however, in

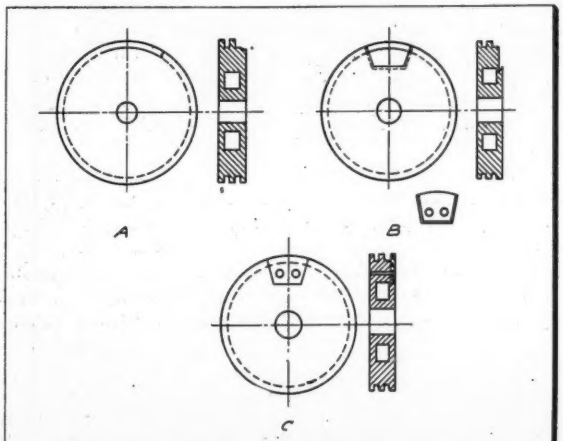


FIG. 1. PISTON HEAD WITH PORTION OF FLANGE BROKEN OFF AND METHOD OF REPAIR

the majority of cases not such a difficult proposition after all. Figure 1A shows for illustration a head with a portion of the flange broken off. Figure 1B shows how a section of the head can be chipped back and dove-tailed to allow the insertion of a small wrought-iron plate, bevelled and filed for a driving fit into the dove-tailed portion of the head. Figure 1C illustrates how the plate can be held securely in the recess by a number of rivets, holes for which are drilled through the plate and head itself, the rivets being peened over into the countersunk openings of the holes.

This piece of work can in the majority of cases be accomplished entirely without recourse to the equipment of a machine shop. The writer repaired a number of flanges in this manner having as extra tools only a small vise drill, a flat bastard file, and a number of small chisels for chipping the recess in the head.

The breaking off of the entire flange, however, presents a different proposition, but the head can be readily repaired providing there is access to a small lathe. A portion of the broken head should be cut away after the manner illustrated in Fig. 2A. A collar is then turned, fitted and riveted to the head as in Fig. 2B.

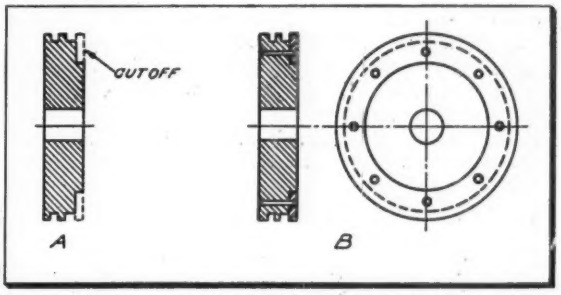


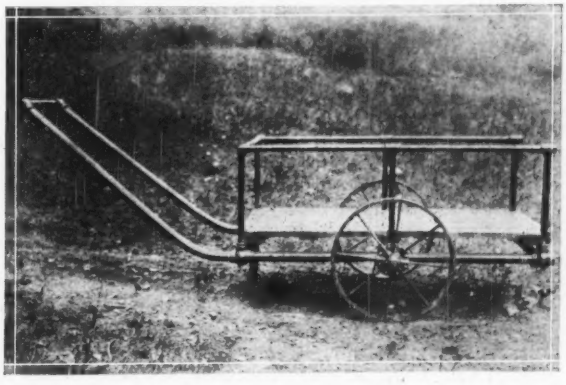
FIG. 2. METHOD OF REPAIRING PISTON HEAD WITH FLANGE BROKEN COMPLETELY OFF

It is true of course that a piston head repaired in either manner will not be as safe in every respect as a new one, but in a great many instances these methods of quick repair can prevent an indefinite shut-down, which is often the result of an extended wait for repair parts from the factory.

F. W. Bentley, Jr.

Home-Made 2-Wheel Push Cart

ACCOMPANYING photograph shows how a home-made 2-wheel "wheelbarrow" or push cart can be built for use in wheeling ash or coal, where it is necessary to move them some distance. The frame



CONVENIENT CART MADE OF PIPES

is made of 1-in. pipe fittings. Six 1-in. side outlet tees (3 with lefthand threads in one outlet), made the corners and angles. The handles were made of the same size pipe. The handles were screwed together first and then the side pieces screwed onto them, the

right and left cross pieces being screwed in last, making one solid frame.

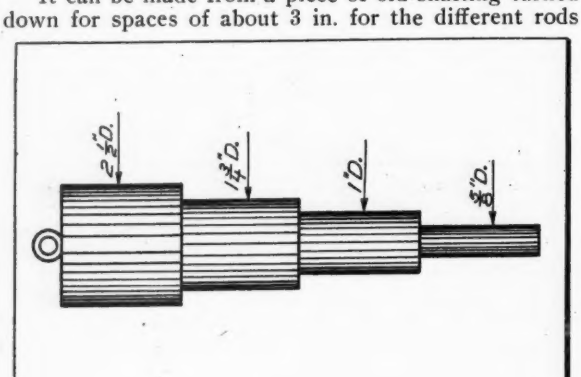
The 2 center fittings were drilled out with a ¾-in. drill, and through the holes was put a piece of ¾-in. steel shafting. Two wheelbarrow wheels 17 in. by 2 in. were drilled out to ¾ in. through the hubs, the ends of the hubs being cut off leaving them about 6 in. long. The wheels were put on the ends of the shaft and nuts put on. The railing was made of ½-in. pipe 1 ft. high. A hard-wood platform was made to set on the tees which contained ½ in. by 1-in. bushings. Side boards or any kind of a dump box can be made to fit inside of the railing.

This cart was built with the platform 2 ft. wide by 3 ft. long, and it would carry 3 or 4 times as much as an ordinary wheelbarrow. L. M. Johnson.

Packing Mandrel

ACCOMPANYING sketch is of what I call a packing mandrel and I have found it to be one of the most useful tools in the engine room so I am sending it in the hope that it may come in useful to others.

It can be made from a piece of old shafting turned down for spaces of about 3 in. for the different rods



MANDREL FOR CONVENIENCE IN CUTTING PACKING

on engines, pumps, compressors, etc. All one has to do is to select size of rod on mandrel for which packing is needed and a dozen pieces can be cut if needed in a few minutes. If a piece of shafting is not at hand a piece of hard wood will do equally as well for it can be finished off smooth with sand paper. A hook can be inserted in the end for hanging it up.

W. H. Bainbridge.

Heating System Ejector

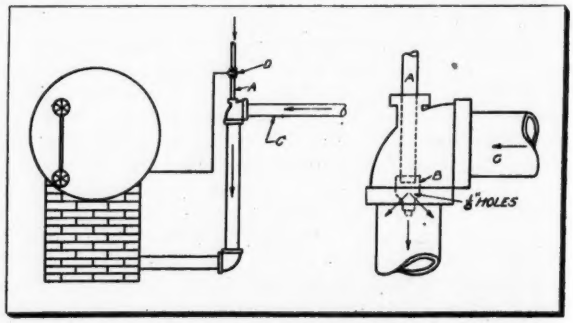
THE accompanying drawings relate to the proper installation of heating system ejector, which was installed in an office building where I am employed. The object is the production of an economic, serviceable and efficient ejector in connection with the heating system, thus forming a nearly perfect vacuum on the returns of heating system to receiving tank.

In this building the blower system and direct radiation in which the two combined are installed, the boilers are fed by the way of receiver and the condensation from main heaters or blast coils at the fan, drips from high and low-pressure piping, which are free from oil, are trapped into a vented receiver and from here pumped back into boiler.

Fresh water which is required to replace that lost by various wastes and used to condense the exhaust steam enters the ejector at A, passes down through nozzle or spraying device B, which is extended into discharge pipe on the end of tee for about ½ in. or a little less; this fresh water supply is admitted to the receiver by an automatic water feeder, flowing continuously and maintaining a constant level in the receiver.

This ejector is composed of a 5 by ¾ by 5-in tee with ¾-in. cold water supply pipe extending into tee, having on one end of pipe a ¾ by ¼-in. reducing coupling, the ¼-in. opening being plugged, with ⅛-in. holes drilled as shown in drawing.

This ejector condenses the vapor and forms a vacuum on returns of heating system by using the additional make-up water through regulating valve D, the water



EJECTOR AND PIPING OF RETURNS FROM HEATING SYSTEM

flowing continuously enters the ejector through nozzle or spraying device B, then is imparted with vapor and condensation from returns entering C, at a comparatively high velocity, being drawn into vented receiver and returned direct to the boilers without loss of its heat.

The hot water service for the building is also in connection with receiver having a special pump for that purpose in supplying the building, as in this case a sufficient amount of cold water can be used. The vapor coming with the water of condensation on entering ejector is instantly condensed and practically a perfect vacuum is obtained on the returns from heating plants.

L. A. Danner.

IT IS VERY ESSENTIAL that no metal work in the battery room, especially over the cells, be exposed to the action of the acid fumes and gases. The structural iron work of the building can be very well protected by encasing it with expanded metal work upon which a coating of cement plaster is placed. This if kept well painted with a good lead paint will prove a very satisfactory way of protecting all structural metal work. Pipes and small portions of metal work can be protected by sheet lead, or if they are not in too close proximity to the cells can be protected sufficiently by frequently cleaning and painting with an acid resisting paint such as Hydrex preservative paint. This paint is very thick and heavy, and forms a strong, heavy protective coating, and does not contain any coal tar to corrode the metal. It is claimed to be acid, gas, and sulphur fume-proof. The battery rooms in all new electric sub-stations of the New York Central Railroad are painted with this preservative paint.

One great danger of exposed iron work in a battery room if it extends over the battery, is that the sulphate of iron formed by the action of the fumes may fall into the cells and impair the purity of the electrolyte, thereby seriously damaging the plates.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Refrigeration Questions

I AM in charge of a cold storage plant that uses the Carbondale system. 1. What should the specific gravity of the strong liquor from the ammonia pump be? 2. Is the hydrometer test an accurate one? 3. Should the brine enter the cooler at top or bottom and why?

F. M. J.

A. 1. The usual strength of the ammonia liquor as it passes to the expansion coils is 29.5 per cent by weight. Sometimes it will run as high as 30 per cent. Under these conditions the specific gravity will run from 0.901 to 0.897, the lower specific gravity being for the stronger liquor.

This corresponds to a hydrometer reading of 26 deg. Baume, and the hydrometer reading is a reasonable good test of the strength of the liquor.

This answers also your second question.

3. For the arrangement in your plant, the brine should enter the cooler at the top, for 2 reasons: First, the brine is then cooled as it passes downward through the cooler, which is the natural method of circulation; second, the warm brine will come in contact with the warmest gas as it is leaving for the absorber, and as the brine flows from the cooler, it will come in contact with the coldest gas as it comes in from the expansion valve. There will be, therefore, the maximum transfer of heat between brine and gas at all parts of the cooler.

A. L. R.

Vacuum Pump for Heating System

WILL you please tell me how the size or capacity of a vacuum pump required to produce a vacuum of 15 in. on a heating system of a given number of square feet radiation is determined? The plant has about 9500 sq. ft. of radiation.

A. The proportions of the vacuum pump for heating system depend on the pressure of steam carried and the amount of condensed steam to be removed. If you want to produce 15 in. vacuum and have, say, 100 lb. steam pressure, you would first reduce the 15 in. to pounds per square inch, which would give you about 8 lb., allowing for some slip. Then the area of the steam piston is to the area of pump piston inversely as the pressures. This would give you the size of the steam piston after the pump piston is decided on.

As to the capacity of the pump, if you have 9500 sq. ft. of radiation, it would give off, say, about 200 B. t. u. per sq. ft. per hour. This for your 9500 sq. ft. would be 1,900,000 B. t. u., which at 900 B. t. u. per pound of steam condensed would give you 2100 lb. of steam and air to be taken care of, or about 253 gal. an hour, or 4¼ gal. a minute, so that the pump cylinder should have that capacity.

I think you will see from this the method of going about such computation. The capacity of the pump would, of course, be taken from the builder's rating.

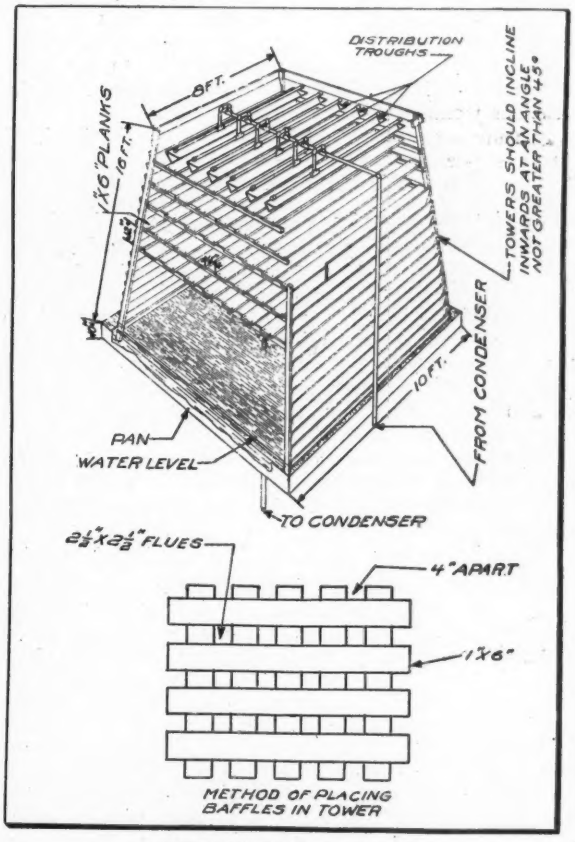
A. L. R.

Cooling Tower Problem

WHAT size of open air cooler is needed to lower the temperature of cooling water from ammonia condenser and gas engine; 40 gal. per minute; high temperature of water, 86 deg.; temperature of the atmosphere, 90 deg.; temperature of makeup, city water, 78 deg.?

Subscriber.

A. As we do not know the conditions under which your tower will be required to work, or, in other words, where you propose locating it, we would therefore, advise you to build your cooling tower with one square foot of surface to each gallon of water cooled per minute. This would give a tower 5 ft. by 8 ft. square at the top, and not less than 16 ft. high—20 ft. would be preferable—and you should have slats or baffle strips made of 1 in. by 6 in., placed about 2½ in. apart, and placed 12 in. apart vertically, as shown in sketch.



SKETCH OF COOLING TOWER

You should be able, with a tower of this size, to lower the temperature of water to about 8 deg. below that of the atmosphere, or within 2 to 4 deg. of the

temperature of a wet bulb thermometer. If you can locate the tower in an open yard or on top of your building, where it would have the benefit of a free air circulation, it would be possible to use less than one square foot to each gallon per minute. You will find a cooling tower will perform its work much better when the air is dry or the humidity is low, as it will then carry off vapor very rapidly and in large quantities. W. H. Biesley.

Pump Question

WE are going to put in a single-acting triplex pump in connection with our duplex pump. Please inform me what size of triplex pump with crank shaft running 25 revolutions per minute will be required to do the work of a duplex pump 5¼ by 3½ by 5 in., running 19 strokes one way for each piston, or if it were connected up like engine it would be making 19 revolutions per min. E. D.

A. You do not state whether your duplex pump is single or double-acting. We, therefore, assume that it is a double-acting pump, and with the dimensions you give, should deliver 159 gal. a minute. If it is a single-acting pump, it will deliver half this amount.

A triplex pump, operating at 25 r.p.m., should have cylinder dimensions of approximately 7 by 10 in.; or to correspond with the single-acting duplex pump, the dimensions would be one-half these.

N. G. M.

Air Engine Problem

IF an air compressor has a capacity of 90 cu. ft. of free air a minute and delivers it at 90 lb. gage pressure, what volume does the compressed air occupy? My proposition is this: I have an air engine 3½ by 3½ in., which is to be run by an air compressor rated 90 cu. ft. of free air per minute and 90 lb. pressure at 250 r.p.m. The engine will run about 350 r.p.m. but will be run on intermittent service (about 3 min. with 6 min. rest), but the air compressor will be run continuously.

What size reservoir would be necessary so the pressure would not drop too suddenly?

I would like to have the calculations on this if possible.

Also, how many cu. ft. of free air does it require to give one cu. ft. of air at 90 lb. pressure? L. R. R.

A. The compression of air may occur according to either one of two methods: first, the isothermal method if the air compressor is water jacketed; second, the adiabatic if there is no jacket. In either case the compression is not quite according to the classified method but is near enough for practical purposes.

In the isothermal, because of the water jacket on the cylinder, the air is kept at practically constant temperature during the entire compression. In the adiabatic the assumption is that no heat is lost, that the air is compressed and keeps within it all the heat which is expended upon it as work during the compression.

In the first case the pressure varies inversely as the volume, that is, as the volume gets smaller the pressure increases, absolute pressures being understood. The pressure at the beginning of the compression would be, atmospheric, about 15 lb., at the end 90 + 15 or 105 lb. The volume of 90 cu. ft. of free air after compression would then be 90 ÷ 105 and multiplied by 15, or 12.85 cu. ft.

In the case of adiabatic compression the law of compression may be expressed in either of two ways. Absolute pressure times volume, divided by absolute temperature, is a constant; or, as we know how the temperature varies during adiabatic compression, the pressure times (volume raised to the 1.406 power) is constant. As the last mentioned form of computation involves the use of the table of logarithms it is easier to use the first form.

Assuming the conditions that you give, we should have at the beginning of compression 90 cu. ft. of free air for the volume, 15 lb. absolute for the pressure, and assuming this to be at 60 deg. Fahrenheit, the ordinary temperature of the air, it would be 60 + 460 or 520 deg. absolute. This would give us for our constant, then, 15 × 90 ÷ 520, or 2.6.

Now to find the volume after compression we have that the pressure is 90 lb. gage or 105 lb. absolute and from a curve of temperature we find that the Fahrenheit temperature would be about 450 deg., or the absolute would be 450 + 460 or 910 deg.. We should then have 105 times the volume divided by 910, which is equal to 2.6, and to get the volume we should have to multiply 2.6 by 910 and divide by 105. This gives us 22.5 cu. ft. As stated before, the compression will not be either exactly isothermal, which would give 12.8 cu. ft., nor adiabatic, which would give 22.5, but somewhere between these two, and it is safe to assume that in actual working it would give about 20 cu. ft. if the cylinder is not water-jacketed and about 15 cu. ft. if it is water-jacketed.

As to your last question, the cubic feet of free air required to give one cubic foot after compression would be 90 ÷ 22.5 if it were adiabatic expansion, or about 4 cu. ft. of free air; or if it is isothermal expansion it would be 90 ÷ 12.85 or about 7 cu. ft. of free air.

Now on the practical problem if you have a 3½ by 3½ air motor, the area of the piston 3½ in. in diameter will be 9.62 square inches. Multiplying by the length of the stroke, 3½, and dividing by 1728 to give cubic feet would give us 0.019 cu. ft. used per stoke. Say this amounts to 0.02 per stroke and then at 350 revolutions per minute a single-acting motor will use 7 cu. ft. a minute or a double-acting would use 14. This is about the normal amount that would be furnished by the compressor, so that the size of the reservoir can be made very small, simply enough to take up the slight fluctuations. A half-cubic foot capacity would seem to be plenty and this, if you make it of 4-in. pipe, would give a piece 6 ft. long, or of 6-in. pipe a piece 2½ ft. long. A. L. R.

IN DISCUSSING Economy of Gasoline Engines before the National Gas Engine Association, A. E. Potter called attention to the following points:

Tests show that for best economy the carburetor must be correctly proportioned to the engine being neither too large nor too small, should provide air in proportion to the gas charge to give a proper mixture, and should give sufficient agitation in the intake to insure that gas and air are thoroughly mixed. This mixture will generally be best secured with a reasonably high vacuum in the intake, to insure high air velocity.

Ignition should be set as early as possible without producing knocking in the cylinder, and the throttle as nearly closed as will give the required power and speed. In a multicylinder engine it is important that the timing be carefully synchronized so that ignition takes place at the same point in the stroke in each cylinder.

The difference between carelessness and care on these points may make a difference of 25 per cent in full economy.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Electrical Engineering Problem

I HAVE 2 direct-current dynamos, compound wound, of 50-kw. capacity each, 110 v., and carrying 300 amp. each, connected in parallel. One of them blew the fuse on the positive side, and the ammeter immediately showed that this dynamo had dropped from 300 amp. to 150 amp., and still carried a load of 150 amp. There was no ground or short. This machine carried this load of 150 amp. for about 4 hr. with the fuse blown. The question in my mind is how it could do it.

Possibly some of the readers can enlighten me, and I should be glad to hear from any of them who can solve the problem. W. M. Scott.

Stuffing Box Packing

IN reply to the article by Horace M. Hastings, in Jan. 15 issue, will say that I had the trouble of which he speaks on one of our Gaskill pumping engines. I had packed the stuffing box, but not so full as he states, and after running a couple of hours noticed the nuts were coming off; this happened not over 10 days ago, so it is fresh in my mind.

J. N. Weyher.

Packing Problem

IN answer to Horace M. Hastings' question in Practical Engineer of Jan. 15, in my experience I have found that the nuts on a stuffing box will work off when they are not drawn up excessively tight. I have used soft packing mostly and tighten it up enough to be firm, but no more. In going the rounds of inspection, I occasionally find a nut worked loose and in a few instances nearly off the bolt.

As he states, the bolts were only ⅛ in. past the gland, so I think the nuts worked off, caused by the vibration of the engine or by the rod being slightly out of true and rubbing the gland at some point of the stroke. However, an inspection of the bolts would show whether the packing was pulled out or not, by the condition of the threads. W. K. M.

Stuffing Box Packing

RELATIVE to inquiry by Horace M. Hastings, page 144, Jan. 15 number of Practical Engineer, he evidently implies that fibrous packing was used to pack the engine referred to, but he does not tell us whether or not the engine was packed again after the mishap with the same kind of packing as was used before the mishap, nor does he tell us whether or not the second job of packing held reasonably well. I believe there was nothing substantial in the packing he used, and that under the action of heat it just withered away or evaporated like the Irishman's whiskey.

Some years ago I packed the valves of a Corliss engine with fibrous packing. The valve stem stuffing boxes were about 2 in. deep; the packing was ⅝ in. wide, and otherwise fitted the box snugly, as it should. I put 3 rings in each of the 4 boxes, expecting to put in an additional ring next day. Meantime I had to pull on the nuts several times to keep the box tight and the next day I put 3 rings more in each box, and a couple of days later there was not enough packing in all 4 boxes to pack the stems of a ½-in. globe valve. Where did it go? The packing didn't go anywhere. The packing stayed where it was put and the filler melted and ran out. That is what occurred in Mr. Hastings' case, also, I believe. T. C. R.

Massachusetts Examinations

IN answer to the inquiry on page 1257 of the December 15 issue, as to requirements in Massachusetts for second class fireman's license, I had the opportunity to listen to 2 examinations for second class fireman's license in Worcester some time ago.

Here are some of the questions asked:

1. Where is the fusible plug in a return tubular boiler; from what side are they put in; what are they there for?

2. Could you tell the difference between plugs for vertical boilers and horizontal return tubular boilers? What are they filled with?

3. What would you do if your boiler suddenly loses water? What is the cause of it? What causes pitting in boilers and how would you prevent it?

4. How do you find the water level in your boiler?

5. How do you blow out your water column?

6. What would happen if someone shut the top or bottom connections for your gage glass?

7. What would you look for when you opened fire doors, or when you are inside your boiler or in the back connection?

You must have been doing firing or coal passing somewhere. They will not ask any unreasonable questions if you can show that you have experience. Any man that has been firing stationary, steamboat or locomotive boilers and has taken interest in the work can surely pass this examination.

I saw one man fail because he did not know how to blow out the water column; the examiner told him that he would rather give a man a license that knows how to blow down a water column than a man that can take indicator cards.

Don't be afraid to try if you think you can safely operate boilers, as boilers are the main thing. Pumps and injectors are not what they will judge you by; of course, the more you know about them, the better. First of all, do not tell them any lies; it will spoil all your chances of getting a license. C. W.

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CARE, USE AND STORAGE OF TOOLS

Requisites of a first class engineer have been discussed in many magazine articles, several having mentioned certain points which should receive special attention in the course of his training. One point, however, which is too often overlooked, is the care, use, and storage of tools.

As the work of the engineer cannot be carried on without the use of tools, the first and most important thing, it would seem, is for the young engineer to learn the proper use and care of the tools with which he has to do his work. This done, he certainly should have a system for the storage of his tools.

Although an engineer is not supposed to be a professional tool maker, yet he should know the more simple operations of tempering, grinding, sharpening, etc.

A good many engineers who are good mechanics have no respect whatever for their tools. It is no uncommon practice to throw a dozen files of different shape and size into a box or drawer together. Every time the drawer is moved the files rub together and this injures the cutting edges.

Men sometimes use standard taper reamers to ream out a hole in a piece of cast-iron pipe. Such practice as removing concrete which had spattered upon the engine bed, with a scraper which was intended for scraping bearings, is absolutely inexcusable.

It is not necessary either to state the result of running the top of an old work bench which was full of filings, bits of iron, etc., through a wood planer.

The utter disregard which some men have for good tools is surprising. Therefore, one of the first and most important things to teach the young engineer is the use and care of tools.

The next most important thing is that he learn to have a certain place for each and every tool and to see that it is put back in its place the minute it is out of use.

ATTENTION TO DETAILS

As we study power plant equipment and methods we are impressed more and more with the fact that details have not been perfected. It can hardly be expected that a newly invented machine will be so perfect that a few years, at most, of constant use will not develop defects that can be improved, but we still have boiler and economizer explosions, run-away engines, engines wrecked by water, the smoke nuisance and a hundred and one other dangerous as well as expensive results which could be avoided if proper attention were given to details.

Without going further into the causes of these disasters, when investigation is made, in the majority of cases, the blame is placed upon some one in the plant who has not attended to some detail, not because he did not know better, but because he was not alert. "Vigilance is the price of safety," not only when dodging street cars, but in the power plant as well.

ENGINEERS' INCITATION CLUB

WITH a very definite object, the engineers of St. Louis have formed this organization to collect and give publicity to data showing the results obtained from isolated power plants. Their data shows, according to their statements, that in plants of 50 hp. or over, where steam is needed for heating or drying, the operation of an individual plant is cheaper than central station service, besides the advantage of skilled help always at hand, and incidental mechanical service.

The club has prepared a log book covering 1913, enabling an engineer to keep a record of output and service rendered, and the cost of every item of expense in producing light, heat, and power, copies of which are furnished to members of the Club.

On Jan. 25 the Club held a Ball and Vaudeville at Liederkranz Hall at which an unique program was carried out under the direction of the various committees.

The various numbers were as follows:

Grand March—"Fight for the Isolated Plant," Incitation Club; Vaudeville—"When the Packing is on the Bum" See Hillerman; Waltz—"Ide Sooner Have a Four Valve," Pat Haradon; Vaudeville—"O'Brien Water Tube Makes Money," McKeown; Two-Step—"Any Speed You Want from Brownell," Schwaner; Vaudeville—"Down-Draft Objects to Smoke," Wangler; Waltz—"The Red Barrel," Filley; Vaudeville—"When You Need the Fixer" See Bob. Jacobs; Two-Step—"Watts, the Meter with Fort Wayne," Thomas; Vaudeville—"The Real Thing in Circulation," Rohan; Ostende—"Go as Far as You Like," Mathews; Waltz—"Cover Up Your Pipes," Landigran; Two-Step—"Nothing Gets by the Rings," McQuay-Norris; Carnation—"Cookson is the Water Cook for Me," "Oh You Heater"; Waltz—"For Efficiency Get the Ball," Baumes; Tag Two-Step—"McGowan Feeds the Boiler," Hammer; Waltz—"Corliss Engines Bates the World," Phone Olive 76; Ostende—"It's a Close Shave to Get By," Barbers' Union; Two-Step—"Building for the Future," Price Hill; Waltz—"We are All Lit Up To-Night," Briner; Carnation—"Pillow Blocks Have Bearing on Transmission," C. O'Brien; Two-Step—"Corliss Cans the Scale from Boilers," Boyd; Waltz—"Something XXX, Walshes Fire Brick," Parker; St. Louis—"Staunton Coal is Hot Stuff," Fitzgerald; Two-Step—"What We Join Together, No Man Breaks Asunder," Laclede Iron Works; Waltz—"Waltz Me Around Again Willie," CO_2, Kemp; Carnation—"Oh Dear-Born Has the Goods," Eardley; Two-Step—"The Watertown Specialty," P. K. Engineers; Waltz—"We are Going Some, Start the Injector," Penberthy; Two-Step—"The Vacuum System, We Are All Het Up," Iroquois Engineering Co.; Waltz—"Start Right, With a Good Foundation," Garner Mahoney; Home Sweet Home—"The Switchboard is in the Corner," Wurdack. Lights out.

Officers of the Club are: President, E. E. Francis; vice-president, Chas. Sharkey; treasurer, A. W. Rhein; secretary, H. C. McLaughlin. Chairmen of the committees were, on Arrangements, J. P. McDonough; on Reception, J. W. Wood; on Floor, W. L. Bowers.

The Club has 233 members in all, holds frequent meetings for lectures and discussions, and is thoroughly wide-awake.

NEWS NOTES

ALFRED KNIGHT CHITTENDEN, Forester of the United States Indian Service, Department of the Interior, has been appointed Assistant to the Director of the Engineering Experiment Station and Lecturer on Timber and Timber Resources in the College of Engineering of the University of Illinois. Mr. Chittenden was born in 1879 in New Haven, Conn. He studied methods of forest management in Germany, France, Switzerland, Austria and England. He entered the United States Forest Service, Department of Agriculture, in 1903, and has since carried on timber work in practically every state. In 1911 he was appointed Forester in the United States Indian Service, Department of the Interior, and was placed in charge of the timber resources of the Indians.

Among Mr. Chittenden's publications may be mentioned Bulletins No. 55 and 58 of the United States Forest Service, entitled respectively "Forest Conditions of Northern New Hampshire" and "The Red Gum," and a bulletin of the Wisconsin State Board of Forestry, entitled "Forest Taxation in Wisconsin."

Mr. Chittenden began his service with the Engineering Experiment Station the first of February.

PREPARATIONS ARE now well under way for the Panama Pacific International Exposition to be held in San Francisco during 1914. Thirty-three states have agreed to participate, and 23 have selected sites for the state buildings. An exposition ground of 625 acres has been provided on the northern shore line of the Peninsula of San Francisco, overlooking the Golden Gate, and in this space a great garden has been laid out with ample provision for all exhibit buildings, parks, exhibition spaces and for other purposes that may be necessary.

To make sure that all parts of the exposition will be ready on time, the contracts for all exhibit buildings are being let on the basis that they must be ready for occupancy on June 25, 1914, while the date of opening is February 20, 1915, thus giving ample time for the installation of all exhibits and cenveniences.

THE INTERSTATE OIL MILL Superintendent's Association will be in convention in Atlanta, June 4, 5, 6, 1913, at the Auditorium Armory. The plans include the most comprehensive exhibit of oil mill machinery and appliances that has ever been shown in the South and the main room of the auditorium has been reserved for the exhibits. Both operating and still exhibits will be shown and an attendance of 250 oil mill superintendents is expected.

KELLY FOUNDRY & MACHINE CO., of Goshen, Ind., has no connection with the Kelly Foundry Co., of Elkhart, Ind. The latter concern has recently passed into the hands of a receiver, but the Kelly Foundry & Machine Co., of Goshen, Ind., is in prosperous condition and ready to furnish its product of power plant specialties, particularly Kelly grates, on short notice.

DEVELOPMENT OF the big falls of the Missouri River, near Great Falls, Montana, and Thompson Falls, on Clark's Fork, of the Columbia River, is now insured under direction of Charles T. Main, who has been awarded the contract for the engineering work. The surveys of these developments have started. It is probable that the Big Falls development will have a capacity of 125,000 hp. and the one at Thompson Falls, 50,000 hp.

NELSON VALVE CO., of Chestnut Hill, Phila., has arranged with the Schumaker-Santry Co., 141 Milk St., Boston, Mass., to act as its distributing agents throughout the New England territory.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

UNWATERING THE CATSKILL AQUEDUCT

WITH the exception of the Panama Canal, the greatest engineering project in the world is now in process of construction in New York City, and as the New York World Magazine stated some time ago, "consequently New York is only vaguely aware of its existence." In this case however, there is a very good reason for the New Yorker's lack of knowledge, as none of the work is in evidence. Practically every bit of it is being carried on 500 to 700 ft. below the surface, where the Catskill Aqueduct, large enough to admit a Pullman car, is being cut through the solid rock upon which the city is built.

FIG. 1. GOULDS VERTICAL DUPLEX MINE SINKING PUMP 475 FT. BELOW STREET LEVEL

One of the important problems the contractors had to solve in this work, as in all deep subterranean projects, was to provide an effective method of preventing the work from being flooded by seepage water. Without this precaution, work on the aqueduct would be impossible.

In selecting the equipment for this work, the consideration of first importance was reliability. On an undertaking of such magnitude an interruption of the work would mean an enormous loss to the contractor. The pumping equipment, being depended upon to prevent any stoppage due to water accumulation, had to be selected with this feature of reliability foremost. Another feature the contractors had to take into account was flexibility of the equipment with reference to installation. It had to be such that it could be easily installed any place that it might be needed, however restricted, and for some of the services it had to be portable.

In the City of New York the construction is from 500 to 700 ft. below the surface at the deepest points, and in solid rock. On the contract of the Pittsburgh Contracting Co., extending from 177th Street Bronx into Manhattan, a total distance of about 30,000 ft., the depth varies from 270 to 480 ft. Seven shafts were sunk by this company about a mile apart, and 2 vertical duplex 4 by 6-in. mine sinking pumps, made by The Goulds Mfg. Co., Seneca Falls, N. Y., were installed in 2 of these shafts. A Goulds 3½ by 6-in. pump was installed in each of the other 5 shafts. Each pump is equipped with a direct-connected Westinghouse induction motor, 3-phase, 60-cycle, 220-v., 10-hp. The pumps are standard outfits guaranteed for 50 gal. a minute against heads of 475 ft. and are delivering from 50 to 60 gal. a minute.

While sinking the shafts, the pumps were suspended from cables and used vertically, their normal position in mine service. After the shafts were finished, the same pumps were placed in a horizontal position and used as station pumps in the tunnel, for pumping from sumps to the surface. Although not built for service in this position, the contractors state that they are giving excellent service as station pumps.

On the contract of Holbrook, Cabot and Rollins, extending from Cooper Square, Manhattan, out for a distance of about 5 miles into Brooklyn, 8 Goulds single-acting, triplex pumps are used. Air lifts were tried first and found unsatisfactory. Two of these pumps are of the 8 by 10-in. size, having a capacity of 300 gal. a minute each against an elevation of 360 ft. The other 6 are 5 by 8 in., having a capacity of 100 gal. a minute each at an elevation of 500 ft. These pumps are driven by 2-phase, 60-cycle, General Electric motors.

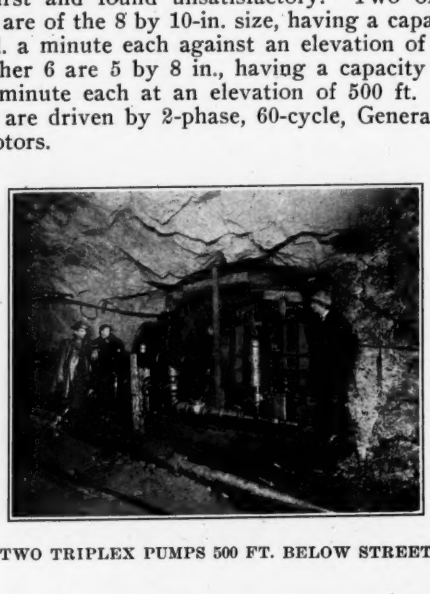


FIG. 2. TWO TRIPLEX PUMPS 500 FT. BELOW STREET LEVEL

On the Mason and Hanger Co. contract at Cornwall-on-Hudson, a 7 by 12-in. Goulds triplex pump with a 50-hp. direct-connected Westinghouse motor and 2 5 by 8-in. Goulds belt-driven triplex pumps are used. The latter are shown in Fig. 2 and it will be noted the pumps were installed in a recess cut in the rocks at the side of the tunnel.

IMPROVING THE CONDUCTIVITY AT JOINTS

ENGINEERS usually take considerable care in calculating the size of bus bars, cables and other conductors of electricity, so that the resistance will be kept as low as possible and the heat loss at a minimum. Many engineers, however, do not appreciate the fact that the saving due to the use of liberal copper in electric conductors may be entirely nullified at the joints, and of course, the more joints that there are in a circuit, the greater will be the loss at these points.

It is frequently supposed that copper surfaces are smooth and regular; this is not true however, as a micro-photograph shows hundreds of mountain peaks and deep irregular valleys and not even a single level ridge. Now, if we put 2 bars like this, face to face, they can touch each other only at the high points and the current, instead of having the entire cross section of the surface of contact as a path, has to concentrate at the few peaks which touch, consequently making the contact resistance high. Even though we put considerable pressure on the joint, the valleys are not forced into contact and moisture creeps in and fills them up with a nonconducting oxide, which serves to bring in more and more moisture until the mountain peaks themselves are covered.

Now, it is evident that if we had some kind of putty, which is a good conductor of electricity, we could use it for filling up the valleys and get practically a perfect contact. Then, if we could put into the putty a liquid metal, which would fill it as water fills snow, we would get even better results, and if this liquid would stick to the copper as tightly as does water when put between 2 glass plates, we would get even better conductivity, since the force of adhesion is very great when acting at close range.

Optimus plastic alloy is just such a metal putty and just such a liquid metal is released from the solid alloy which is used to prepare chemically the copper and to hold the metal paste in the valleys. These alloys adhere so tightly that there is practically no contact resistance left and the 2 copper plates are electrically continuous. Moisture cannot get into the joints and the putty will not corrode.

It is customary to allow 1 sq. in. of copper contact surface to 50 amp. in bus bars, switches, ammeter shunts, etc. But with Optimus plastic alloys, 1000 amp. per sq. in. can be allowed at the joint with practically no more losses than occur in a solid conductor of the same cross section; furthermore, if the contacts are properly prepared, they will remain perfect for years.

Granting that there is a high resistance at the contact between copper bars permanently bolted together, it is evident that greater losses occur at switches where the pressure between the 2 parts cannot be great, and tests prove this to be the case. When the ordinary switch is closed, contact is only made at a few high points; while the engineer may think he has several square inches in contact, as a matter of fact, only a few mountain peaks are touching. Here again, Optimus plastic alloy can be applied and the losses greatly reduced.

Optimus plastic alloy is now being used extensively by electro-platers, because, on account of the heavy currents carried in this industry, the heat losses are apt to be large if the joints are not made in the best possible manner.

To show that Optimus plastic alloy is not only theoretically but practically a paying investment the following tests, on 3 different kinds of contacts, made in power plants, are selected.

Building and Witnessed by—	Amperes on switch	Loss in Before application	Millivolts After application	Per cent reduction
Fuller Bldg., ("Flatiron") W. H. Taverner, Mgr. Electrical Dept.....	400	28.5	2.5	91.23
Commonwealth Edison Co. (Chicago), R. F. Schuchardt, Elec. Engr. Watt Meter Stud Test.	1000	18.	1.2	93.33
One square inch Bus Bar Contact Test	1000	1.2	.1	91.66

Optimus plastic alloy is manufactured by the Munning-Loeb Co., of Matawan, N. J., who besides the tests mentioned above, has made other interesting tests, showing conclusively that it pays to make joints in electrical circuits with as low a resistance as possible.

A NEW REFRACTORY CEMENT

For Withstanding High Temperatures

UNTIL within the last few years, fire-clay has been most generally used for laying up brick walls, cementing joints, patching and lining of furnaces, kilns, retorts, etc., where high temperatures are encountered. In spite of its exceedingly short term of usefulness, and the consequent necessity for repeatedly patching and repairing, founders and furnace men have until recently continued to use this material because there has been no substitute which could be generally used. Ofttimes the fire-clay was mixed with certain other materials to serve as "binders." Of course, this compounding entailed considerable trouble and labor, but there had apparently been no alternative than to follow precedent.

The H. W. Johns-Manville Co., New York, has recently put on the market what it terms J-M High Temperature Cement No. 31, which it is said can be used practically whenever working temperatures range between 1500 and 3100 deg. F.

This new material is a dry powder mixture composed of asbestos and other materials of secret preparation. It is mixed with water to the proper consistency (say about 18 to 20 lb. of water to 100 lb. of powder) for working like mortar or tamping around molds.

When used for setting up fire-brick for boilers and furnaces, lining and roofing furnaces of various kinds, or molded into door jambs, lining fire doors, repairing side walls of furnaces, making stay-nut caps, etc., it has considerable mechanical strength. When air dried, it will withstand a crushing strain of 883.5 lb. a square inch. It vitrifies at the comparatively low temperature of 1418 deg. and has a high melting point (3182 deg. F.).

Being semi-acid in character, it can be used with chrome bricks, silica bricks or fire-clay bricks.

It is claimed that experiments conducted with this cement show that it can be successfully used in building doors of angle iron framework without backing, or for making one-piece linings for gas or oil burning crucible furnaces.

IMPROVED STEEL COUPLING FOR HIGH OR LOW-SPEED SHAFTS

A NEW form of flexible coupling made entirely of crucible cast steel, and to dimensions especially suitable for this material, is being introduced by McEwen Bros., Wellsville, N. Y. This McEwen coupling, as it is called, and as illustrated herewith, is said to have the smallest diameter and mass, and therefore the smallest inertia, of any truly flexible coupling on the market.

The keys extend clear through the shafts, are set at right angles and are arranged to permit a marked degree of misalinement, yet because of ample key bearing surface and the exceptionally good lubrication from packing of heavy oil or soft grease, there is no noise or tendency toward serious wear.

THE McEWEN COUPLING

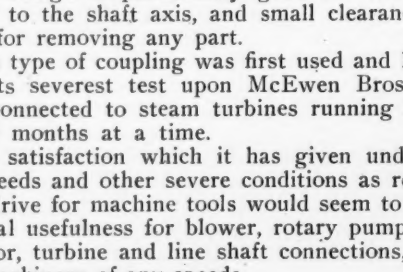
The design is particularly good for withdrawals parallel to the shaft axis, and small clearance is required for removing any part.

This type of coupling was first used and has been given its severest test upon McEwen Bros. pumps direct connected to steam turbines running 24 hr. a day for months at a time.

The satisfaction which it has given under these high speeds and other severe conditions as reversible motor drive for machine tools would seem to indicate a general usefulness for blower, rotary pump, motor, generator, turbine and line shaft connections, and on other machinery of any speeds.

THE HOLT AUTOMATIC STRAINER

THE Holt Automatic Strainer is a device for the automatic removal of all kinds of solid foreign matter, such as ice, rocks, sticks, fish, cinders, leaves, etc., from water supply lines without interrupting the flow of water. It consists of a substantial cast-iron casing, having an inlet and outlet.



SECTIONAL VIEW OF HOLT AUTOMATIC STRAINER

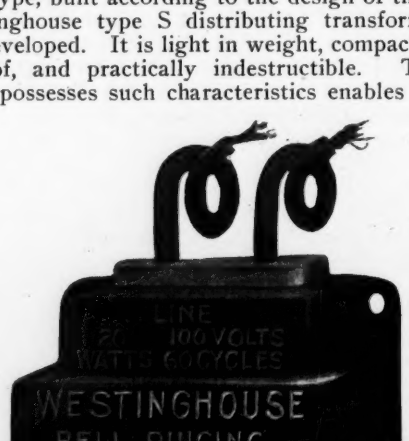
A perforated brass cylinder, having open ends, being interposed between the inlet and outlet of the casing so that the liquid to be strained flows into one end of the perforated cylinder and passes out through the perforations into the outlet of the casing. The foreign matter is retained on the inside of the perforated cylinder until the cleaning shaft is rotated. The blade of the cleaning shaft, which allows 1/32 in. clearance from the inside wall of the perforated cylinder, sweeps the entire inner surface and forces the foreign matter out of the opposite end from that by which the liquid enters into the receiving chamber, from where it then falls by gravity into the sediment chamber.

In practice, all that is required to keep this strainer cleaned, is occasionally to turn the hand wheel connected to the cleaning shaft about 2 complete revolutions, and whenever necessary, clean out the sediment chamber, both operations being performed without interrupting the flow of water through the strainer.

This strainer is made by the Rosedale Foundry & Machine Co., Pittsburgh, Pa.

BELL RINGING TRANSFORMERS

USE of bell ringing transformers has become quite popular and recently a new transformer of this type, built according to the design of the Westinghouse type S distributing transformer has been developed. It is light in weight, compact in size, fireproof, and practically indestructible. The fact that it possesses such characteristics enables it to be



NEW DESIGN OF BELL RINGING TRANSFORMER

mounted in any out of the way place as it requires no attention whatever after its installation and should last a lifetime. It will deliver on open circuits, 8, 16 or 24 volts, and fully loaded 16 volts. It is particularly useful for apartment houses and public buildings.

The coils and magnetic circuit are vacuum dried and impregnated with a moisture-proof insulating compound. After this treatment the complete unit is fitted into its case. The interior of the case is then filled with a specially treated cement with the result that the coils and iron are completely embedded in a fireproof and indestructible compound.

Rubber covered primary leads are brought out of the top of the case through a porcelain bushing and are left of sufficient length to permit connection to the lighting circuit. Binding posts are provided, as

shown in the picture, for the bell circuit, and the transformer is mounted by lugs cast on the case for this purpose. These lugs are so arranged that an air space is provided between the transformer and the wall.

A test of 2500 volts for one minute is applied between the primary windings and the secondary winding and case. The transformer will stand a "dead" short circuit continuously on the bell-ringing side without injury.

NEW POWER PLANTS

A LARGE POWERHOUSE is to be built by the Gonic Manufacturing Co., at Rochester, N. H. The plant will receive its water power from a canal to be constructed from the sawmill dam. A short distance from the house the water will enter an 8-foot iron tube. The sawmill and a portion of the woolen mill will be operated by electrical power.

GEIGERTOWN, PA. Electric Light and Improvement Co., capital stock of $15,000, will take over the old Geigertown mill for a power plant. Possession will be obtained April 1. In the meantime an electrical engineer will investigate the water power possibilities. The company will furnish the territory embraced in the radius of 6 miles with electric light. Application will be made for a charter.

GENERAL MANAGER, W. R. W. GRIFFIN, of the Tri-State Railway and Electric Co., of Ohio, announces new improvements aggregating $2,500,000. The work planned includes a new $2,000,000 power house at East Liverpool, Ohio, new 3200-kw. turbine for the present power station to cost $90,000, and a new 2200-kw. turbine for the Fallston power house, Beaver, Pa., to cost $60,000. The machinery will come from the Westinghouse Electric and Manufacturing Co.

THE MCKEES ROCKS Light, Heat & Power Co., of Pittsburgh, filed articles of incorporation at Dover, Del., on January 17. The company will manufacture electric current for light, heat and power purposes of all kinds. The company is capitalized at $150,000.

F. H. ANSON, managing director of the Atlantic Sugar Refineries, Ltd., has returned to Montreal from St. Johns, after a trip of inspection over the location of the new plant and a visit to New York to confer with the sugar refinery engineers who, under the direction of J. S. Stillman, are working on the plans.

Mr. Anson stated that, according to the arrangements when he left, the first sod for the construction of the $2,000,000 plant would be turned the next morning. The Foundation Co. has charge of this work, contracts with this firm having been signed in New York last week. The foundations are to be ready in 3½ months and work on the superstructure will then be immediately commenced, and the plant is to be ready for shipping sugar to the trade by May, of 1914.

L. R. Wilson, treasurer of the Atlantic Sugar Refineries, Limited, has been stationed in St. John and has opened temporary offices there.

BOOKS AND CATALOGS

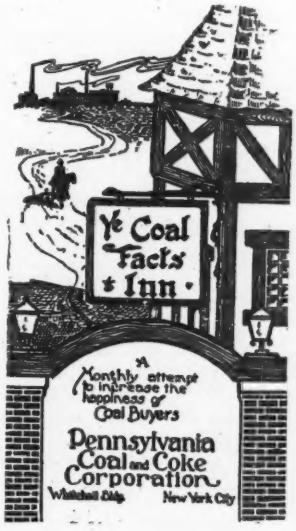
THE BUREAU of Foreign and Domestic Commerce is about to issue a monograph dealing with the manufacture of electrical instruments and meters in Europe. The report is by H. B. Brooks, Commercial agent of the Department of Commerce and Labor, who recently inspected 31 of the most important electrical works of England, France, Germany, and Italy. The products of each concern are treated in detail and descriptions are given of the buildings, equipment, labor conditions, kinds of material used, and the markets in which the products are sold.

STEAM BOILERS by E. M. Shealy. 356 pp., 6 by 9 in., 184 illustrations, cloth binding, New York, 1912; price $2.50.

This is the summary of the work given in the extension course of the University of Wisconsin, and has been written primarily for correspondence students, hence it is particularly well adapted for individual reading and study. The field covered is indicated by the following subjects: Types of Boilers; Strength of Staying; Heat, Its Effects and Steam Making; Fuels and Combustion; Firing and Smokeless Combustion; Settings, Piping and Accessories; Chimneys; Feed Water and Heaters; Inspection, Care and Testing. The book is well balanced, it is up-to-date in its facts, clear and simple in style, thorough in treatment and an ideal book for the man who is starting the study of power plant engineering.

AT THE SIGN OF Ye Coal Facts Inn, the Pennsylvania Coal and Coke Corporation have gathered Facts and Factlets on your fuel problem which entertain and instruct as the flames leap from the glowing grate. As a sample: "Sis Hopkins' rule 'Nothin' for nothin'" applies not only in buying, but in every phase of life.

"The man who doesn't pay effort in studying can't acquire knowledge."


Ye Coal Facts Inn
A Monthly attempt to increase the happiness of Coal Buyers
Pennsylvania Coal and Coke Corporation
Whitehall Bldg. New York City

The booklet is, as well, one to arouse sober second thought as to where the money goes. And its companion, The Engineer's Problem in Selecting Coal, goes far to help find the answer to the question. They come from the Penna. Coal & Coke corporation, Whitehall B'ld'g, New York.

THE LUNKENHEIMER CO., has recently issued its calendar for 1913.

FROM ASHTON VALVE CO., we have received a large calendar in colors. Copies may be obtained by sending 10 cents to the company at 271 Franklin St., Boston.

THE NEW CALENDAR of Cling-Surface Co., is decorated with interesting views in brown, illustrating the use of Cling-Surface.

CHAIN GRATE STOKERS made by Illinois Stoker Co., Alton Ill., have among other features a system of baffling between and below the chains to prevent the passage of air through the rear end of the chain. The catalog illustrates them fully, giving views of interiors where they are used.

LETTERS TO BUSINESS MEN including a discussion of the tariff question and the change of administration, besides a description of the company's boiler compound, is the title of a booklet from Hawk-Eye Compound Co., 357 W. 63rd St., Chicago.

H. W. JOHNS-MANVILLE CO., has just issued a circular on J-M flexible metallic combination hose for steam and pneumatic service. Several advantages of the interlocking spirals of the armor are given and a sectional view shows the details of construction.

NATIONAL ELECTRIC Lamp Association offers a number of new bulletins on electric lighting. Bulletin 10C shows the performance and characteristics of Mazda lamps designed for steam railway use. Bulletin 8D describes Mazda low-voltage and miniature lamps, the latter including general battery and novelty battery lamps. These bulletins and others now available may be had by addressing the engineering department of the company at 4411 Hough Ave., Cleveland, Ohio.

BULLETIN NO. A4034, recently issued by the General Electric Co., is devoted to that company's long life flame arc lamp, known as Type "W." This lamp is for street illumination, and is designed to operate on alternating-current series circuits. Bulletin No. 4993, descriptive of the company's Type RI single-phase motors, supersedes its previous bulletin, No. 4858, on this subject.

TRADE NOTES

IN COMMEMORATING its foundation 25 yr. ago, Warren Webster & Co., wishes its friends happiness and prosperity and expresses its appreciation of their co-operation in a tasteful and gracefully worded reminder.

AT THE NEW ENGLAND Hardware Dealers' Association exhibit, to be held at the New Auditorium, Springfield, Mass., Feb. 25 to 27, the Magnolia Metal Co., of New York, will have on display a complete line of its antifriction metals in booth No. 83. J. M. Litchfield, the New England representative, will be in charge of the booth.

IN CLOSING ITS YEAR, the L. S. Starrett Co., of Athol, Mass., addressed to its employes a letter complimenting them on their efficiency and loyalty, thanking them for their interest, and giving to each employe a sum equal to 2 per cent of the wages paid to him during the year 1912, as a recognition of the value of his increased efficiency to the business of the company.

THE METALLIC PACKING & MFG. CO., of Elyria, Ohio, wishes to announce that, regardless of any statements to the contrary, its factory or product is not controlled in any way by others connected with the sale or manufacture of fibrous or other packings. It is not a branch of any other company, but is absolutely independent, and no other makers have any further interest in its factory than the privilege of buying its product.

LYONS BOILER WORKS during the past year has received orders from the United States Government for 12 boilers to be used on tow and dredge boats.

THE SANFORD RILEY STOKER CO., Ltd., Worcester, Mass., is now placing on the market a new automatic stoker which has a mechanical movement of the fuel bearing surfaces, so that the continuous movement of fuel and ash down the slight incline results in a continuous cleaning. Like all other underfeed stokers, this one is smokeless, even when forced to far beyond the normal capacity of the boiler; a booklet giving a complete description of the construction and operation of this stoker is under preparation, and will shortly be issued.

PERU CASTING AND MACHINERY Co., of Peru, Indiana, purchased on Jan. 4, from the Brown Commercial Car Co., of Peru, Indiana, the foundry and machine shop formerly occupied by the Otis Elevator Co. They will manufacture high grade, grey iron and semi-steel castings, rough machined or assembled, and will be ready for operation about April 1. The parties concerned in this transaction are C. E. McCampbell, foundry superintendent, R. M. Carter, machine shop superintendent and I. H. Barbee, mechanical engineer, all from Milwaukee, Wisconsin.

AMONG PLANTS INSTALLED recently by the York Manufacturing Co., the following are noted:

Danville Artificial Ice Co., Danville, Ill., one 40-ton flooded can ice making plant, with 65-ton vertical single-acting compression side; Sawyer Biscuit Co., Chicago, Ill., one 17-ton belt-driven refrigerating compression side and refrigerating plant; Chattanooga Iron & Coal Co., Chattanooga, Tenn., two 125-ton vertical single-acting compression side, cross-compound engine and brine refrigerating plant; San Benito Ice & Cold Storage Co., San Benito, Texas, for its Bay City plant, one 65-ton belt-driven refrigerating vertical single-acting Compression side, and 35-ton raw water ice making plant; San Benito Ice & Cold Storage Co., San Benito, Texas, for its Harlington, Texas, plant,,. one 20-ton belt-driven refrigerating compression side and direct expansion refrigerating plant; San Benito Ice & Cold Storage Co., San Benito, Texas, for its San Benito plant, one 50-ton raw water ice making plant; McKenzie Brothers, Plainfield, N. J., one 4-ton steam-driven refrigerating compression side and refrigerating plant; R. J. Pile, Friedens, Pa., one 11-ton steam-driven refrigerating compression side and 40-ton raw water ice making plant; Baltimore County Water & Electric Co., Baltimore, Md., one 4-ton refrigerating compression side and refrigerating plant; Van Nuys Hotel, Los Angeles, Cal., one 8-ton belt-driven compression side and refrigerating plant; Napa State Hospital, Napa, Cal., one 10-ton vertical single-acting belt-driven compression side, and 3-ton raw water ice making plant; New York Central and Hudson River R. R. Co., Grand Central Station, New York, one 17-ton belt-driven compression side, 3-ton raw water ice plant and brine refrigerating system; Senor Bosch, Guauajay, Cuba, one complete 10-ton ice making plant; Midvale Steel Co., Philadelphia, Pa., one 45-ton belt-driven compression side and water cooling plant; Grant Rohrer, New York, N. Y., one 6-ton belt-driven compression side and refrigerating plant; Dempsey Hotel Macon, Ga., two 8-ton belt-driven compression sides.

Sparks From The Advertising Pages

How high is your percentage of personal business efficiency?

In other words, how does what you are, compare with what you might be?

That it would be pretty hard to answer this with any degree of accuracy, there is no doubt, but as a matter of fact the present sales-manager of a prominent manufacturing concern asked himself this self-same question some years ago, took a personal inventory and then began to forge ahead.

At that time this sales-manager was one of five young men who were employed by the house as salesmen. But although he worked just as hard and had just as good a territory as the other four, he was invariably fifth on the list when it came to comparing the results accomplished.

Things had not continued long in this fashion, however, before he stopped to make a thorough analysis of the situation. Then came the personal inventory—and a comparison of his own natural ability with that of the four other salesmen.

He figured that the man who was fourth on the list—just a bit above him—was just that much better endowed; and that he would therefore have to study and work about four hours more every week in order to offset this difference in apparent natural ability.

To offset the difference between the third man's ability and his own, he figured that it would take approximately two hours more; and to make up for the difference in natural selling ability between himself and the second man on the list he was confident that it would take still another hour of extra work in addition to the four that were necessary to make him the equal of the fourth man and the six that were necessary to make him the equal of the third.

But to make himself the equal of the salesman who headed the list was a big problem, for that man was far and away ahead of the other four. To make himself the equal of this man, he figured that he would have to add at least ten hours of study and hard work to the extra labor which he had already decided necessary to make himself the equal of the other three.

If he added the total—seventeen extra hours of conscientious effort—to his present schedule, he felt that he would eventually be the superior of three out of his four rival salesmen and the equal of the best.

But this wasn't enough.

He must pass the first man.

So he added still another hour, bringing his total up to eighteen hours a week, and resolved to take three extra hours a day and devote them to a study of the selling problems of his firm.

That man brought his percentage of business efficiency up as near the century mark as it was possible for him to do so. Today, he is the sales-manager of his firm and the other four salesmen are working for him; yet be believes that all four of them began the race with better natural equipment than he did.

Practical Engineer's advertising section offers you a semi-monthly opportunity to make yourself more efficient in your chosen profession. Get into the habit now of spending a few extra hours each week in familiarizing yourself with means of securing greater efficiency in your plant. Your own personal efficiency will increase as your knowledge of ways and means of securing greater efficiency in your plant increases.

Begin now—with this issue—and let the advertising pages of Practical Engineer help you to increase your own professional efficiency.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By first class gas engine operator. Past 6 years operating and repairing horizontal and vertical gas engines, 12 to 500 h. p. All-round machinist. Strictly temperate. Own full set machinists tools. Age 38. Married. Address Box 276, Practical Engineer, Chicago, Ill. 2-15-1

POSITION WANTED—AS ENGINEER or helper in small plant, temperate, references. G. S. Voorhies, Orchard, Nebr. 2-15-1

DO YOU NEED MEN?—All clerical, commercial and technical departments. Charges low,—one reason we get efficient men. Efficient Service Co., 1340 Monadnock Bldg., Chicago.

Wanted

WANTED—IF YOU KNOW the peculiarities of a steam boiler—its "ins and outs"; if you can talk with conviction; if you're sober and a hustler—we have an opening that you might fill to our mutual advantage. A practical engineer who has had selling experience, or one who thinks he can sell Boiler Specialties on a basis of remuneration that we know will prove attractive, will receive full particulars promptly on receipt of application. Write us. Address Box 278, Practical Engineer, Chicago, Ill. 2-15-2

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—SALESMEN calling on firms with stationary engineers, to write us for desirable open territory, where they can soon build up permanent business with our guaranteed product insuring repeat orders. Address 322 Real Estate Trust Bldg., Phila., Pa. 2-15-24

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once. tf.

WANTED—A SALESMAN familiar with the handling of moderate power internal combustion engines. Address Box 275, Practical Engineer, Chicago, Ill. 2-15-2

BACK ISSUE WANTED—Have you a copy of Practical Engineer, January 1907, in good condition to exchange for a year's subscription. Notify Subscription Department at once.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

WANTED—SALESMEN SELLING Steam Plant Supplies, to carry as side line, IDEAL PUMP VALVES and PLUNGER PACKING. Best Valve proposition on the market. Liberal commission and protection in territory allotted. Several entire and part States open. Sample weighs four ounces, easily carried in pocket. If you are looking for a good side line, address, giving full particulars as to territory covered. Lake Erie Boiler Compound Company, Buffalo, N. Y.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money. Write to Subscription Department. tf.

WE NEED MEN—All departments—clerical, commercial and technical. Charges low. Work covers the U. S. Efficient Service Co., 1340 Monadnock Bldg., Chicago.

For Sale

FOR SALE—1—14 x 20-in. Left Hand Bal. slide valve Atlas engine. In A1 shape—no fly wheel. Used 5 years. Reason for selling, installing larger unit. Price $150.00 F. O. B. La Salle, Ill. John J. Callahan, Callahan Ice Co., La Salle, Ill. 2-15-1

FOR SALE—FOUR DIRECT CONNECTED engine and generator sets 25 to 75 kilowatt capacity. Two 17x15-inch straight line engines, built for direct connection or belted service. One 14x12-inch, late type, automatic and one 16x36-inch Corliss engine, water tube and horizontal boilers of all sizes. Twenty-two round, open steel tanks 10 feet 6 inches by 7 feet high. H. P. Brearley, 90 West St., New York, N. Y. 2-15-4

FOR SALE—Three 150 H.P. HRT. Boilers (Massachusetts specifications), quadruple riveted, double butt strapp, 140 lb. insurance certificate, $550 each, Duzets & Son, Hudson Terminal, New York.

FOR SALE—A 32 H. P. HORNSBY-AKROYD Oil Engine with starting device, in very good condition; also a 15-ton Challoner refrigerating machine, oil separator, double pipe ammonia condenser and high and low pressure gauges. These are also in good condition. For particulars inquire of the Rahr Br'g Co., Oshkosh, Wis. 1-1-6

Patents and Patent Attorneys

PATENTS AND TRADEMARKS secured. Write for terms. Harry Patton, 330 McGill Bldg., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G Street, Washington, D. C. 2-1-2

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges, bound in leather. tf.

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf.

REFRIGERATION—Any engineer desiring a working knowledge of Ice and Refrigerating machinery should study "Audel's Answers on Refrigeration"—just published in two parts, written in plain language—price $4, postpaid. Money back if not pleased. Catalog free. Theo. Audel & Co., publishers, 72 5th Ave., New York. 2-1-6